Geol Survey

Guide to the Geology of the Rock Cut State Park and Rockford Area, Winnebago County, Illinois

Wayne T. Frankie, Dennis R. Kolata, and Richard C. Berg

Field Trip Guidebook 1999C September 11, 1999
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Department of Natural Resources
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Cover photo *Rockford Sand and Gravel Company, Farm Quarry (photo by W.T. Frankie)*

Geological Science Field Trips The Geoscience Education and Outreach Unit of the Illinois State Geological Survey (ISGS) conducts four free tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who prepare earth science units. Grade school students are welcome; but we ask that grade school groups be supervised by at least one adult for each five students. High school science classes should be supervised by at least one adult for each ten students. All other minors must be accompanied by a parent or guardian.

A list of guidebooks of earlier field trips for planning class tours and private outings may be obtained by contacting the Geoscience Education and Outreach Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964. Telephone: (217) 244-2427 or 333-4747.

Seven USGS 7.5-Minute Quadrangle maps (Belvidere NW, Caledonia, Durand, Pecatonica, Rockford North, Shirland, and South Beloit) provide coverage for this field trip area.

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

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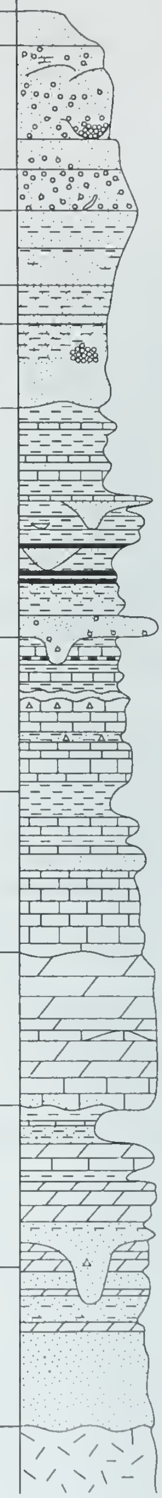
CONTENTS

Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals	Quaternary 0-500'	Holocene	10,000	Recent– alluvium in river valleys
			Pleistocene Glacial Age	1.6 m	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt, loess and sand dunes; covers nearly all of state except northwest corner and southern tip
		Tertiary 0-500'	Pliocene	[5.3 m 36.6 m]	Chert gravel, present in northern, southern and western Illinois
			Eocene	57.8 m	Mostly micaceous sand with some silt and clay; presently only in southern Illinois
			Paleocene	66.4 m	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0-300'		[144 m 286 m]	Mostly sand, some thin beds of clay, and, locally, gravel, present only in southern Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0-3,000' ("Coal Measures")		320 m	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0-3,500'		360 m	Black and gray shale at base, middle zone of thick limestone that grades to siltstone chert, and shale; upper zone of interbedded sandstone, shale, and limestone
	Age of Fishes	Devonian 0-1,500'		408 m	Thick limestone, minor sandstones and shales; largely chert and cherty limestone in southern Illinois; black shale at top
	Age of Invertebrates	Silurian 0-1,000'		438 m	Principally dolomite and limestone
		Ordovician 500-2,000'		505 m	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500-3,000'		570 m	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
		Precambrian			Igneous and metamorphic rocks; known in Illinois only from deep wells



Generalized geologic column showing succession of rocks in Illinois.

ROCK CUT STATE PARK AND ROCKFORD AREA

The Rock Cut State Park and Rockford area geological science field trip will acquaint you with the *geology**, landscape, and mineral resources of part of Winnebago County, Illinois. Rock Cut State Park and Rockford are located in north-central Illinois. Rockford is approximately 88 miles northwest of Chicago, 195 miles northeast of Springfield, 291 miles northwest of East St. Louis, and 396 miles north of Cairo.

GEOLOGIC FRAMEWORK

Precambrian Era Through several billion years of geologic time, Winnebago County and surrounding areas have undergone many changes (see the rock succession column, facing page). The oldest rocks beneath the field trip area belong to the ancient Precambrian *basement complex*. We know relatively little about these rocks from direct observations because they are not exposed at the surface anywhere in Illinois. Only about 35 drill holes have reached deep enough for geologists to collect samples from Precambrian rocks of Illinois. From these samples, however, we know that these ancient rocks consist mostly of granitic and rhyolitic *igneous*, and possibly *metamorphic*, crystalline rocks formed about 1.5 to 1.0 billion years ago. From about 1 billion to about 0.6 billion years ago, these Precambrian rocks were exposed at the surface. During this long period, the rocks were deeply weathered and eroded to form a landscape that was probably quite similar to that of the present Missouri Ozarks. We have no rock record in Illinois for the long interval of *weathering* and erosion that lasted from the time the Precambrian rocks were formed until the first Cambrian-age *sediments* accumulated, but that interval is almost as long as the time from the beginning of the Cambrian Period to the present.

Because geologists cannot see the Precambrian basement rocks in Illinois except as cuttings and cores from boreholes, they must use various other techniques, such as measurements of Earth's gravitational and magnetic fields, and seismic exploration, to map out the regional characteristics of the basement complex. The evidence indicates that in southernmost Illinois, near what is now the historic Kentucky–Illinois Fluorspar Mining District, *rift* valleys like those in east Africa formed as movement of crustal plates (plate *tectonics*) began to rip apart the Precambrian North American continent. These rift valleys in the midcontinent region are referred to as the Rough Creek Graben and the Reelfoot Rift (fig. 1).

Paleozoic Era After the beginning of the Paleozoic Era, about 520 million years ago in the late Cambrian Period, the rifting stopped and the hilly Precambrian landscape began to sink slowly on a broad regional scale, allowing the invasion of a shallow sea from the south and southwest. During the 280 million years of the Paleozoic Era, the area that is now called the Illinois Basin continued to accumulate sediments deposited in the shallow seas that repeatedly covered it. The region continued to sink until at least 15,000 feet of sedimentary strata were deposited. At various times during this era, the seas withdrew and deposits were weathered and eroded. As a result, there are some gaps in the sedimentary record in Illinois.

Geologic Setting of Winnebago County The earth materials in Winnebago County can be sub divided into two major categories, (1) the solid Paleozoic bedrock below and (2) the loose surficial (nonlithified) Quaternary clay, silt, sand, and gravel that mantles the bedrock. Figure 2 shows the

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* Words in italics are defined in the glossary at the back of the guidebook. Also please note: although all present localities have only recently appeared within the geologic time frame, we use the present names of places and geologic features because they provide clear reference points for describing the ancient landscape.

succession of rock strata a drill bit would penetrate in this area if the rock record were complete and all the *formations* were present. The bedrock consists mainly of Cambrian and Ordovician dolomite, shale, and sandstone deposited between 500 and 450 million years ago. Deep wells drilled in the county indicate that these sedimentary rocks overlie 1.3- to 1.4-billion-year-old Precambrian granite. The loose surficial material of Quaternary age is largely till (a material deposited directly from melting glacier) and outwash (stratified sand and gravel formed in running water from the melting of that ice).

The elevation of the top of the Precambrian basement rocks within the field trip area ranges from approximately 1,200 feet below sea level in northwestern Winnebago County to 2,000 feet below sea level in southeastern Winnebago County. The thickness of the Paleozoic sedimentary strata deposited on top of the Precambrian basement ranges from about 2,100 feet in northwestern Winnebago County to about 2,800 feet in southeastern Winnebago County. The long period of erosion of the bedrock prior to deposition of the glacial deposits left a series of deep valley systems carved into the bedrock.

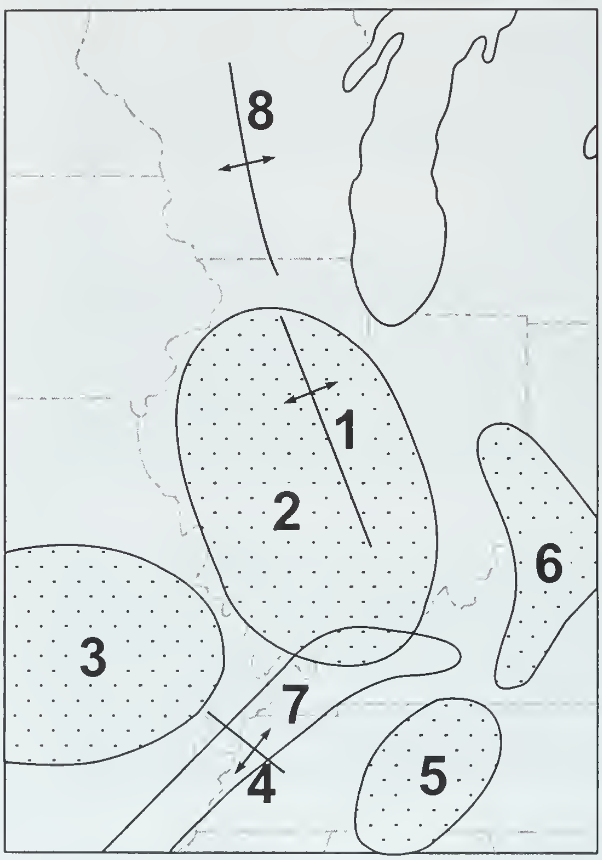


Figure 1 Location of some of the major structures in the Illinois region. (1) La Salle Anticlinorium, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben–Reelfoot Rift, and (8) Wisconsin Arch.

STRUCTURAL AND DEPOSITIONAL HISTORY

As noted previously, the Rough Creek Graben and the Reelfoot Rift (figs. 1 and 3) were formed by tectonic activity that began in the latter part of the Precambrian Era and continued until the Late Cambrian. Toward the end of the Cambrian, rifting ended and the whole region began to subside, allowing shallow seas to cover the land.

Paleozoic Era From the Late Cambrian to the end of the Paleozoic Era, sediments continued to accumulate in the shallow seas that repeatedly covered Illinois and adjacent states. These inland seas connected with the open ocean to the south during much of the Paleozoic, and the area that is now southern Illinois was like an embayment. The southern part of Illinois and adjacent parts of Indiana and Kentucky sank more rapidly than the areas to the north, allowing a greater thickness of sediment to accumulate. During the Paleozoic and Mesozoic, the Earth's thin crust was periodically flexed and warped in places as stresses built up in response to tectonic forces (plate movement and mountain building). These movements caused repeated invasions and withdrawals of the seas across the region. The former sea floors were thus periodically exposed to erosion, which removed some sediments from the rock record.

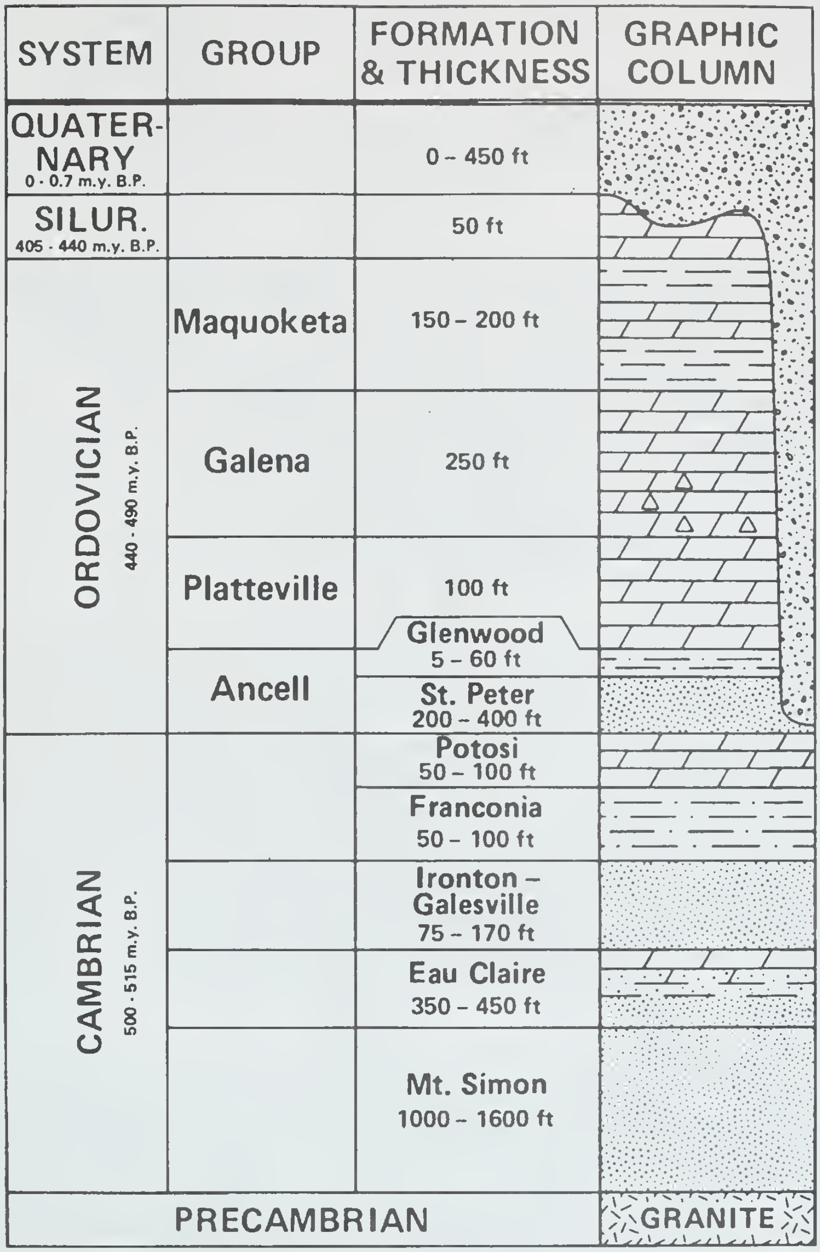


Figure 2 Generalized stratigraphic column for Boone and Winnebago Counties; not to vertical scale (modified from Berg, Kempton, and Stecyk 1984).

Many of the sedimentary units, called formations, have conformable contacts—that is, no significant interruption in deposition occurred as one formation was succeeded by another (figs. 2 and 4). In some instances, even though the composition and appearance of the rocks change significantly at the contact between two formations, the *fossils* in the rocks and the relationships between the rocks at the contact indicate that deposition was virtually continuous. In contrast however, in some places, the top of the lower formation was at least partially eroded before deposition of the next formation began. In these instances, fossils and other evidence in the two formations indicate that there is a significant age difference between the lower unit and the overlying unit. This type of contact is called an *unconformity* (fig. 4). If the *beds* above and below an unconformity are parallel, the

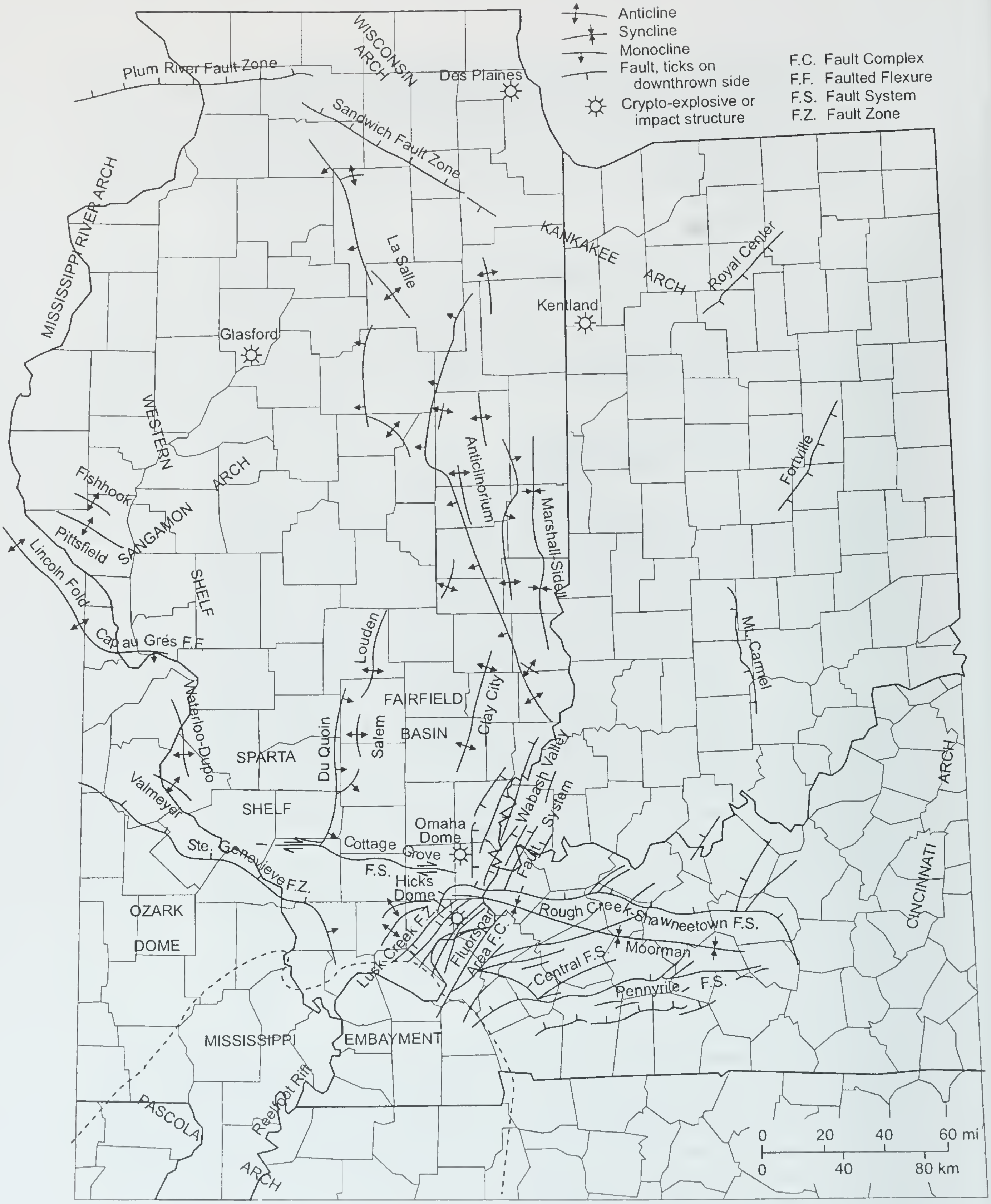


Figure 3 Structural features of Illinois (modified from Buschbach and Kolata 1991).

unconformity is called a *disconformity.* However, if the lower beds were tilted and eroded prior to deposition of overlying beds, the contact is called an angular unconformity.

Unconformities occur throughout the Paleozoic rock record and are shown as wavy lines in the generalized geologic column, located at the front of the guidebook. Each unconformity represents an extended interval of time for which there is no rock record.

Structural Setting of Winnebago County The succession of bedrock units in Winnebago County generally dips in a southeastward direction; the bedrock is broken by vertical fractures that are tens of feet apart and oriented primarily in northwest- and northeast-trending sets. Winnebago County is situated near the crest of a very broad upwarping of the bedrock called the Wisconsin Arch (fig. 3). Erosion along the crest of this arch brings older and older rocks to the surface between northern Illinois and central Wisconsin. No major faults are known in the county; however, two major fault zones occur nearby. These include the Sandwich Fault Zone, extending from near Oregon to near Joliet, Illinois, and the Plum River Fault Zone, extending from Forreston, Illinois, to Maquoketa, Iowa (fig. 3). These fault zones formed about 250 million years ago and have been inactive for at least the last 15,000 years because there is no displacement of the young glacial deposits.

Ancient Environmental History of Winnebago County The bedrock that immediately underlies the glacial deposits in Winnebago County was laid down in a warm, tropical sea that covered the Midwest approximately 450 million years ago during the Ordovician Period. The environment was probably similar to that in the present Bahama Islands. The nearest land was situated about 500 miles to the north in Canada. During Ordovician time, North America straddled the equator, and northern Illinois was positioned at about 25° south latitude (fig. 5). The prevailing wind direction was out of the southeast (Southeast Trade Winds) in contrast to the present westerly wind direction. Occasionally, winds would carry clouds of fine ash into the area from explosive volcanic eruptions that occurred in the region of Alabama and Georgia. These constitute some of the largest volcanic eruptions known on Earth. Two- to three-inch-thick volcanic ash beds can be seen in several rock quarries in the Rockford area.

The flat, featureless Ordovician sea floor teemed with invertebrate animals and algae. Shells of animals including trilobites, brachiopods, bryozoans, crinoids, snails, and clams accumulated on the sea floor along with mud formed from very fine calcium carbonate crystals secreted by algae. The carbonate mud and shells were slowly buried and with time began to solidify, finally turning into beds of limestone. After several million years, numerous limestone beds were formed and stacked one on another. Evidence suggests that perhaps as much as a mile of sedimentary rocks (limestone, shale, sandstone) was deposited in the region after the limestones formed. Hot groundwater containing dissolved salts and metals began to move slowly through the deeply buried limestone

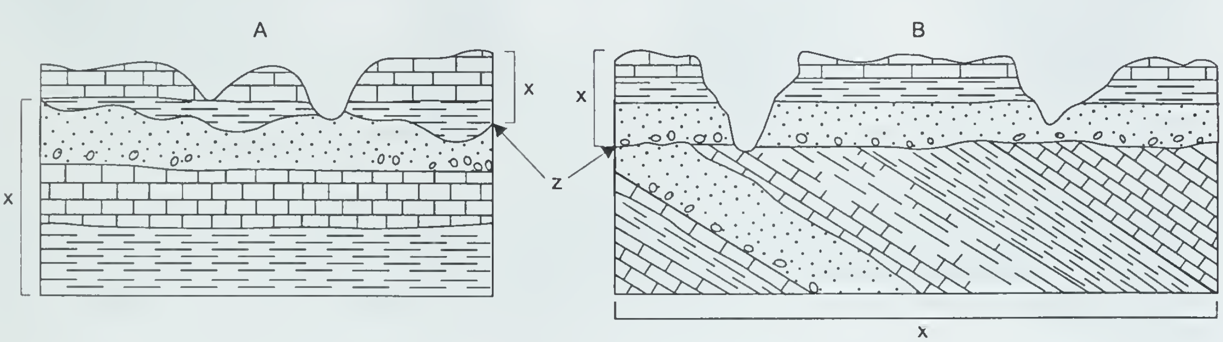


Figure 4 Schematic drawings of (A) a disconformity and (B) an angular unconformity (x represents the conformable rock sequence and z is the plane of unconformity).

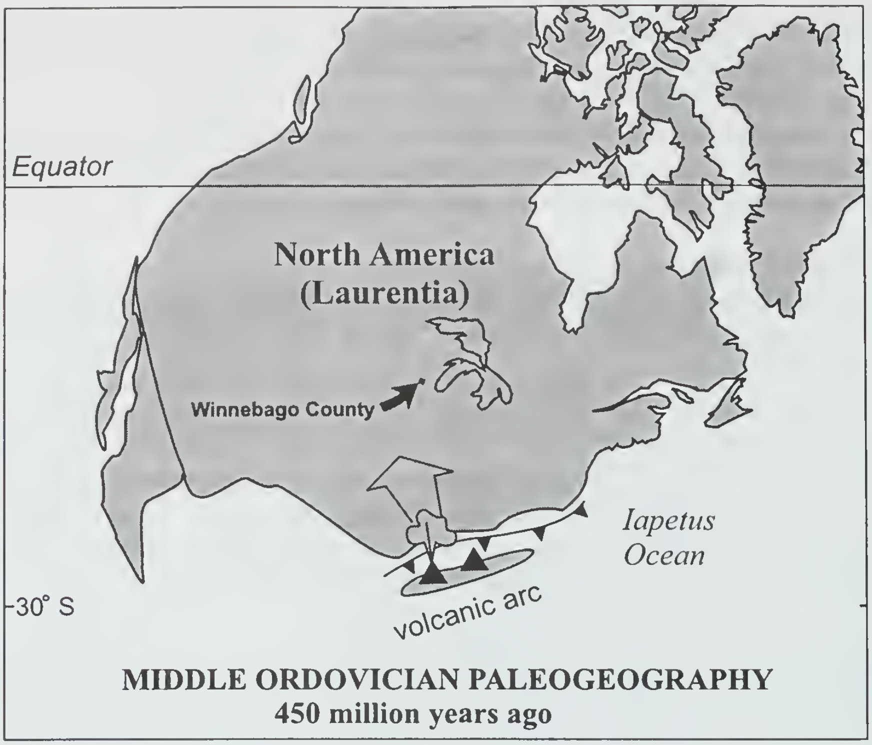
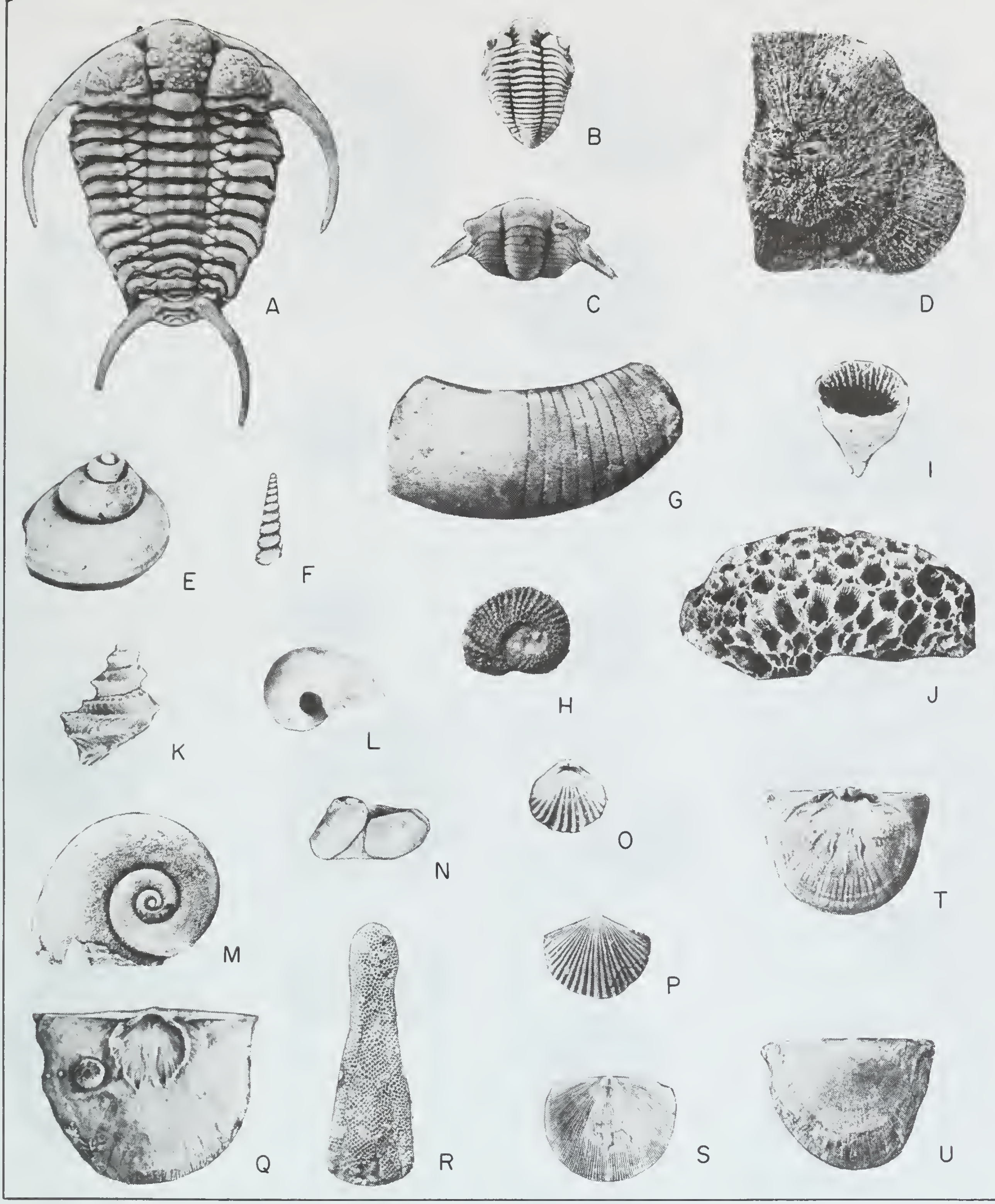


Figure 5 Middle Ordovician paleogeographic map of North America.

and alter the rock to the mineral dolomite. It was during this episode of fluid migration, approximately 270 million years ago, that the lead and zinc deposits in northwestern Illinois and southwestern Wisconsin were formed. Hot brines found their way through fractures in the limestone and dolomite, rose to the surface, cooled, and precipitated sulfide minerals including the lead (galena) and zinc (sphalerite) deposits.

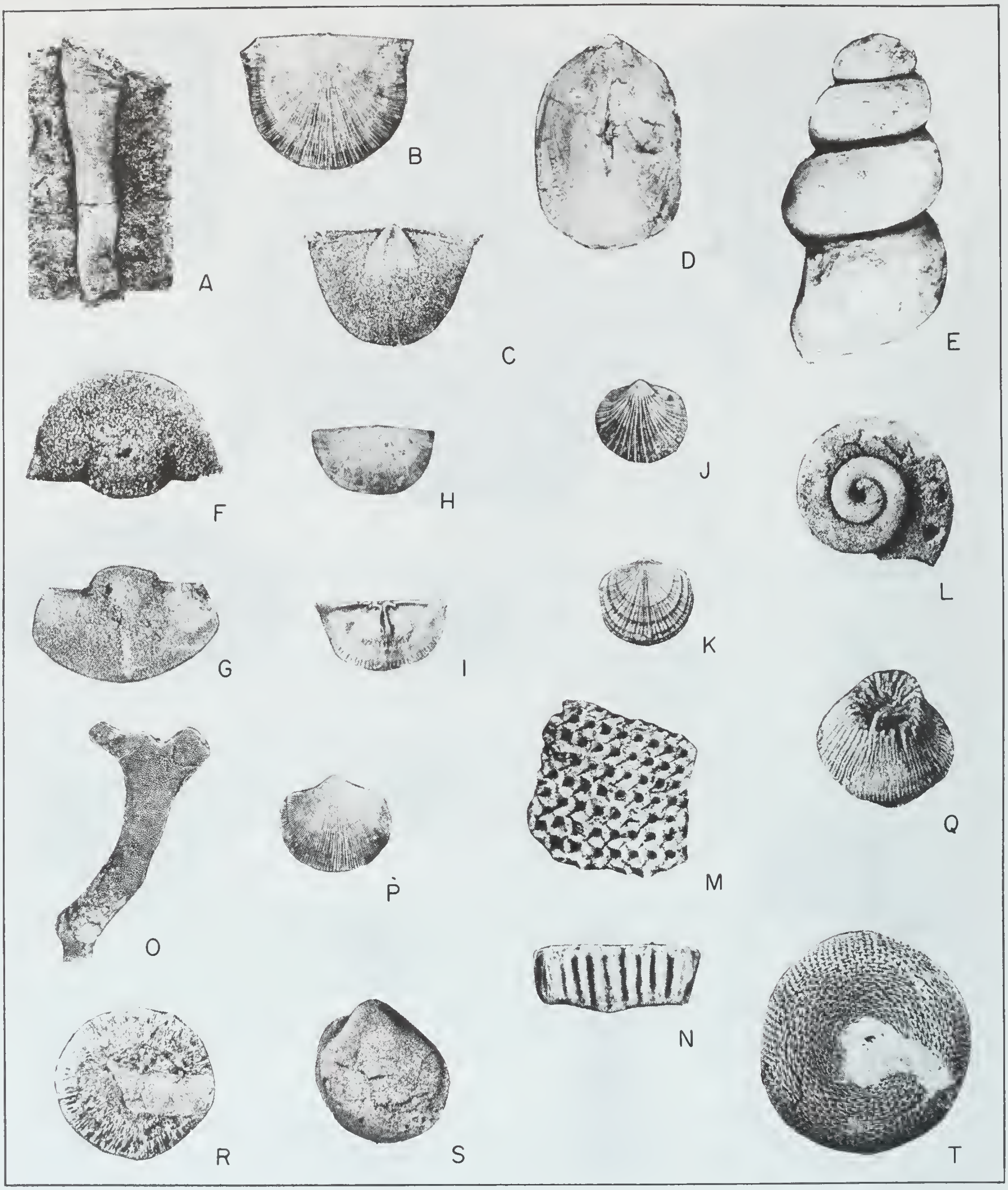
About 250 million years ago, the seas withdrew from the region, and a long period of erosion began that continues today. The mile-thick layer of sedimentary rocks that covered the Ordovician rocks slowly eroded away and exposed the ancient and now petrified sea floor with its abundant fossils. Outstanding specimens of trilobites, crinoids, starfish, and other rare fossils have been collected from the bedrock in Winnebago County, including the oldest fossil sea urchin in North America (figs. 6a and 6b). Many of these specimens are on exhibit at the Burpee Museum of Natural History in downtown Rockford.

Bedrock Names The Ordovician dolomite bedrock in northern Illinois is about 340 feet thick. It is divided into two major units called the Platteville (oldest) and Galena Groups (figs. 7a and 7b). These are further subdivided into numerous subunits mainly on the basis of the relative amount of shale, presence or absence of chert, and fossil content. Knowledge of the subtle subdivisions is useful in finding and producing crushed stone products, siting large construction sites (such as bridges, dams, and nuclear power plants), and in identifying potentially fossiliferous exposures of bedrock. The Platteville is underlain by the Glenwood Formation (poorly exposed in Winnebago County) and the St. Peter Sandstone. The Galena is the youngest bedrock unit present in Winnebago County.



Characteristic fossils of the Platteville Group. A - *Ceraurus* sp., B - *Encrinurus* sp., C - *Thaleops ovata* Conrad, D - *Anthaspidella* sp., E - *Clathrospira* sp., F - *Ectomaria* sp., G - *Richardsondoceras* sp., H - *Phragmolites* sp., I - *Streptelasma* sp., J - *Foerstephyllum* sp., K - *Lophospira* sp., L - *Tetranota* sp., M - *Maclurites* sp., N - *Eoleperditia fabulites* (Conrad), O - brachial valve exterior of *Rostricellula minnesotensis* (Sardeson), P - pedicle valve exterior of *Hesperorthis concava* Cooper, Q - pedicle valve interior of *Strophomena plattinensis* Fenton, R - *Leptotrypa hexagonalis* Ulrich encrusting *Hyolithes baconi* Whitfield, S - brachial valve exterior of *Campylorthis deflecta* (Conrad), T and U - brachial valve interior and pedicle valve exterior of *Öpikina minnesotensis* (N. H. Winchell), all X 1.

Figure 6a Characteristic fossils of the Platteville Group (modified from Willman and Kolata 1978).



Characteristic fossils of the Galena Group. A - *Palaeosynapta flaccida* Weiss, B - pedicle valve exterior of *Rafinesquina trentonensis* (Conrad), C - interior mold of pedicle valve of *Rafinesquina* sp., D - *Pseudolingula iowensis* (Owen), E - *Hormotoma major* (Hall), F and G - cephalon and pygidium of *Illaenus* sp., H and I - pedicle valve exterior and brachial valve interior of *Sowerbyella punctostriata* (Mather), J and K - pedicle and brachial exterior of *Dalmanella* sp., L - *Liospira* sp., M and N - top and side views of *Receptaculites oweni* Hall, O - trepostome bryozoan, P - pedicle valve exterior of *Pionodema subaequata* (Conrad), Q - *Streptelasma* sp., R - basal view of *Prasopora* sp., S - *Vanuxemia* sp., T - *Ischadites iowensis* (Owen), all X 1.

Figure 6b Characteristic fossils of the Galena Group (modified from Willman and Kolata 1978).

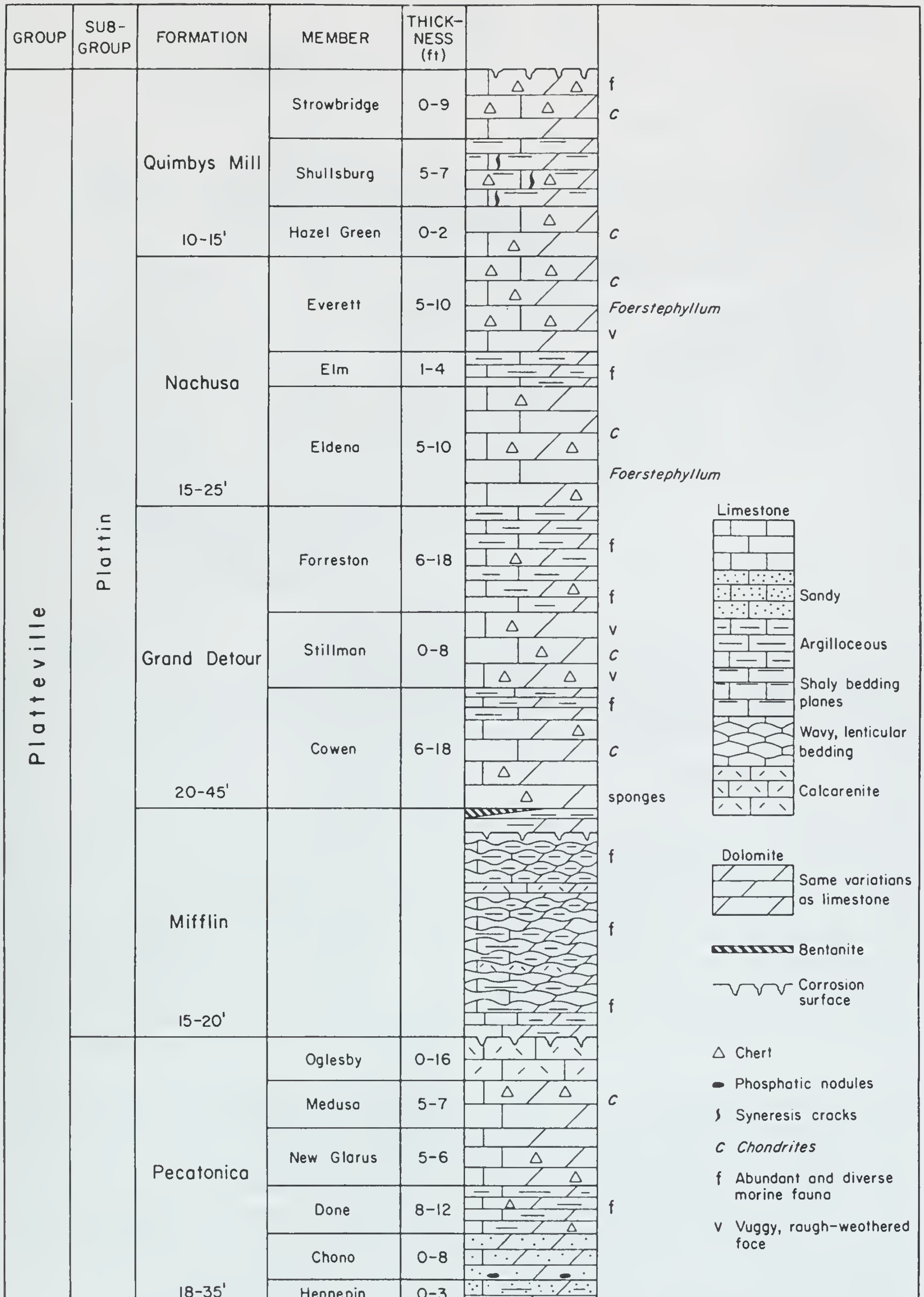


Figure 7a Columnar section of the Platteville Group (modified from Willman and Kolata 1978).

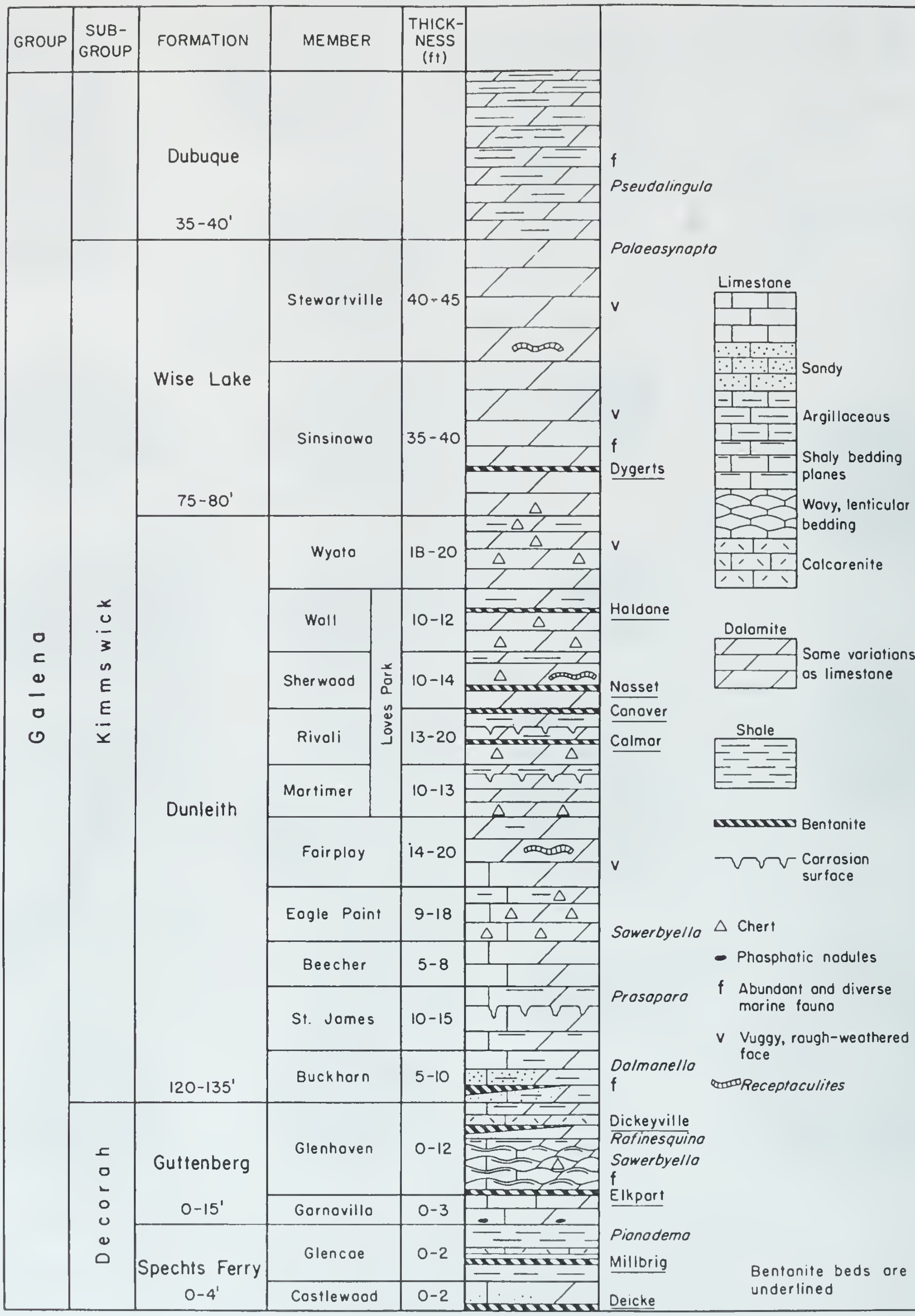


Figure 7b Columnar section of the Galena Group (modified from Willman and Kolata 1978).

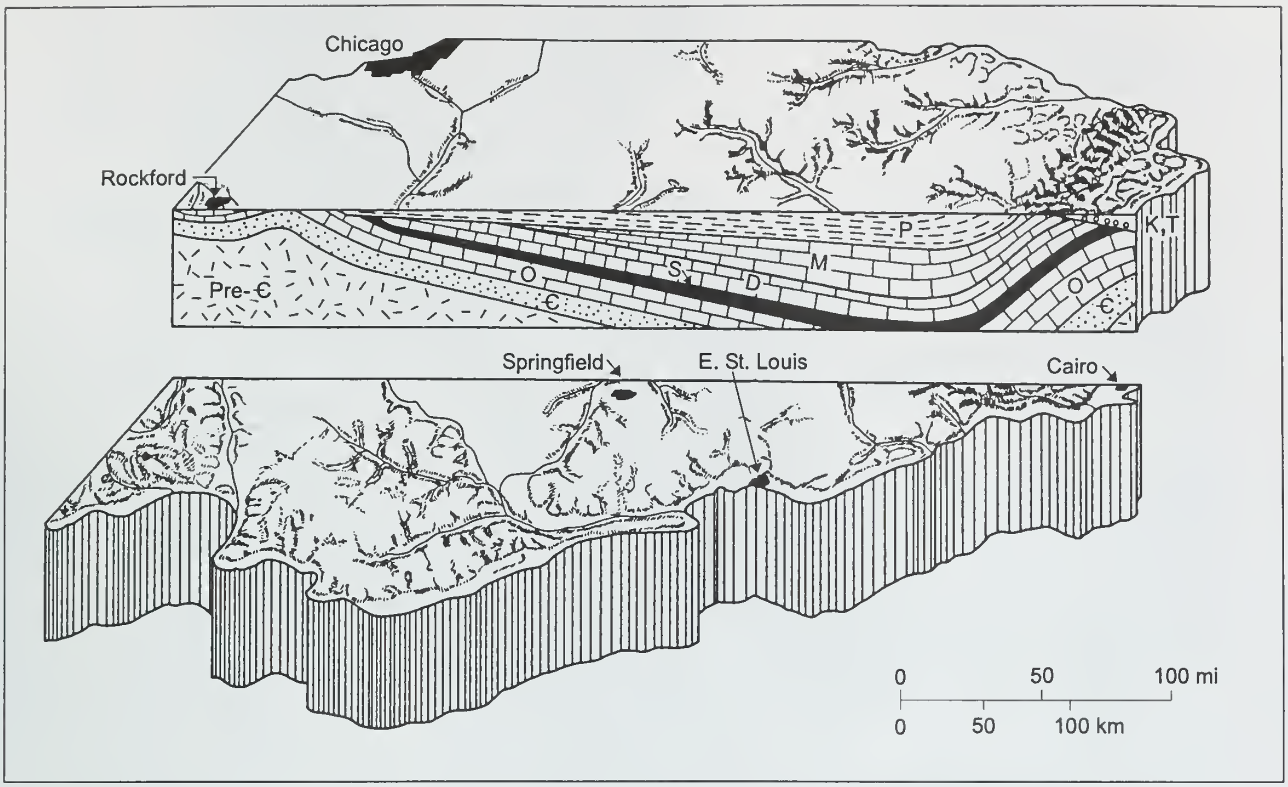


Figure 8 Stylized north–south cross section shows the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-Є) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (Є), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

Mesozoic Era During the Mesozoic Era, the rise of the Pascola Arch (figs. 1 and 3) in southeastern Missouri and western Tennessee produced a structural barrier that helped form the current shape of the Illinois *Basin* by closing off the embayment and separating it from the open sea to the south. The Illinois Basin is a broad, subsided region covering much of Illinois, southwestern Indiana, and western Kentucky (fig. 1). Development of the Pascola Arch, in conjunction with the earlier sinking of the deeper portion of the basin to the north, gave the basin its present asymmetrical, spoon-shaped configuration (fig. 8). The geologic map (fig. 9) shows the distribution of the rock *systems* of the various geologic time periods as they would appear if all the glacial, windblown, and surface materials were removed.

Younger rocks of the latest Pennsylvanian and perhaps the Permian (the youngest rock systems of the Paleozoic) at one time may have covered the area of Winnebago County. It is possible that Mesozoic and Cenozoic rocks (see the generalized geologic column) could also have been present here. Indirect evidence, based on the stage of development (rank) of coal deposits and the generation and maturation of petroleum from source rocks (Damberger 1971), indicates that perhaps as much as 1.5 miles of latest Pennsylvanian and younger rocks once covered southern Illinois. During the more than 240 million years since the end of the Paleozoic Era (and before the onset of *glaciation* 1 to 2 million years ago), however, several thousands of feet of strata may have been eroded. Nearly all traces of any post-Pennsylvanian bedrock that may have been present in Illinois were removed. During this extended period of erosion, deep valleys were carved into the gently tilted bed-

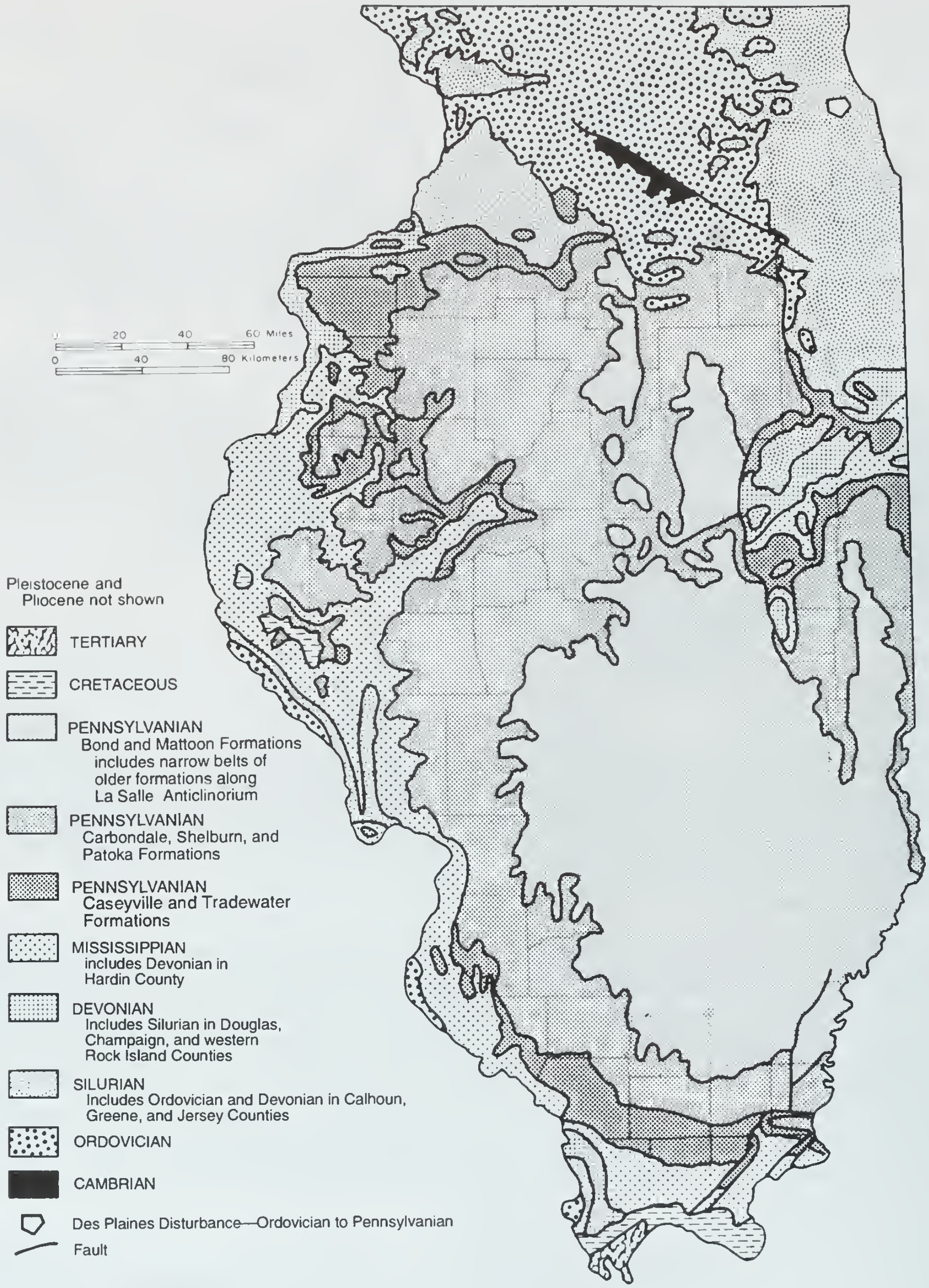


Figure 9 Bedrock geology beneath surficial deposits in Illinois.

rock formations (fig. 10). Later, the topographic *relief* was reduced by repeated advances and melting back of continental *glaciers* that scoured and scraped the bedrock surface. This glacial erosion affected all the formations exposed at the bedrock surface in Illinois. The final melting of the glaciers left behind the nonlithified deposits in which our Modern Soils have developed.

Cenozoic Era: Glacial History A brief general history of glaciation in North America and a description of the deposits commonly left by glaciers is given in *Pleistocene Glaciations in Illinois* at the back of the guidebook.

As stated above, erosion that took place long before the glaciers advanced across the state left a network of deep valleys carved into the bedrock surface (fig. 10). The present topography of Illinois is significantly different from the topography of the preglacial bedrock surface.

During the Pleistocene *Epoch*, beginning about 1.6 million years ago, massive sheets of ice (called continental glaciers), thousands of feet thick, flowed slowly southward from Canada. During the Illinois Episode, which began around 300,000 years before the present (B.P.), North American continental glaciers reached their southernmost position, approximately 340 miles south of here, in the northern part of Johnson County (fig. 11). The maximum thickness of the later Wisconsin Episode glaciers was about 2,000 feet in the Lake Michigan Basin, but only about 700 feet over most of the Illinois land surface (Clark et al. 1988). The last of these glaciers melted from northeastern Illinois about 13,500 years B.P.

The *topography* of the bedrock surface throughout much of Illinois is largely hidden from view by glacial deposits, except along the major streams. In many areas, the glacial drift is thick enough to completely mask the underlying bedrock surface. Studies of mine shafts, water-well logs, and other drill-hole information, in addition to scattered bedrock exposures in some stream valleys and roadcuts, show that the present land surface in the areas of Illinois where the glacial deposits are thickest does not reflect the underlying bedrock surface. The topography of the preglacial surface has been significantly modified by glacial erosion and is subdued by glacial deposits. Wisconsin Episode moraines were deposited in Illinois from approximately 25,000 to 13,800 years ago.

Although Illinois Episode glaciers probably built morainic ridges similar to those formed by the later Wisconsin Episode glaciers, the Illinois Episode moraines apparently were not as numerous and have been exposed to weathering and erosion for approximately 280,000 years longer than their younger Wisconsinan counterparts. For these reasons, Illinoian glacial features generally are not as conspicuous as the younger Wisconsinan features.

The glacial deposits in Winnebago county consist primarily of (1) *till*—pebbly clay, silt, and sand, deposited directly from melting glaciers; (2) *outwash*—mostly sand and gravel, deposited by the rapidly flowing meltwater rivers; (3) *lacustrine deposits*—silt and clay that settled out in quiet-water lakes and ponds; and (4) *loess*—windblown sand and silt. The loess (pronounced "luss") that mantles the bedrock and glacial drift throughout the field trip area, was laid down by the wind during all of the glacial episodes, from the earliest pre-Illinois Glacial Episode (approximately 1.6 million years ago) to the last glacial episode, the Wisconsin Episode (which occurred approximately 25,000 to 12,500 years ago).

This yellowish brown loess is generally 2 to 5 feet thick and occurs on the uplands throughout Winnebago County. The loess, which covers most of Illinois, is up to 15 feet thick along the Illinois River Valley and is more than 50 feet thick along the east edge of the Mississippi River Valley.

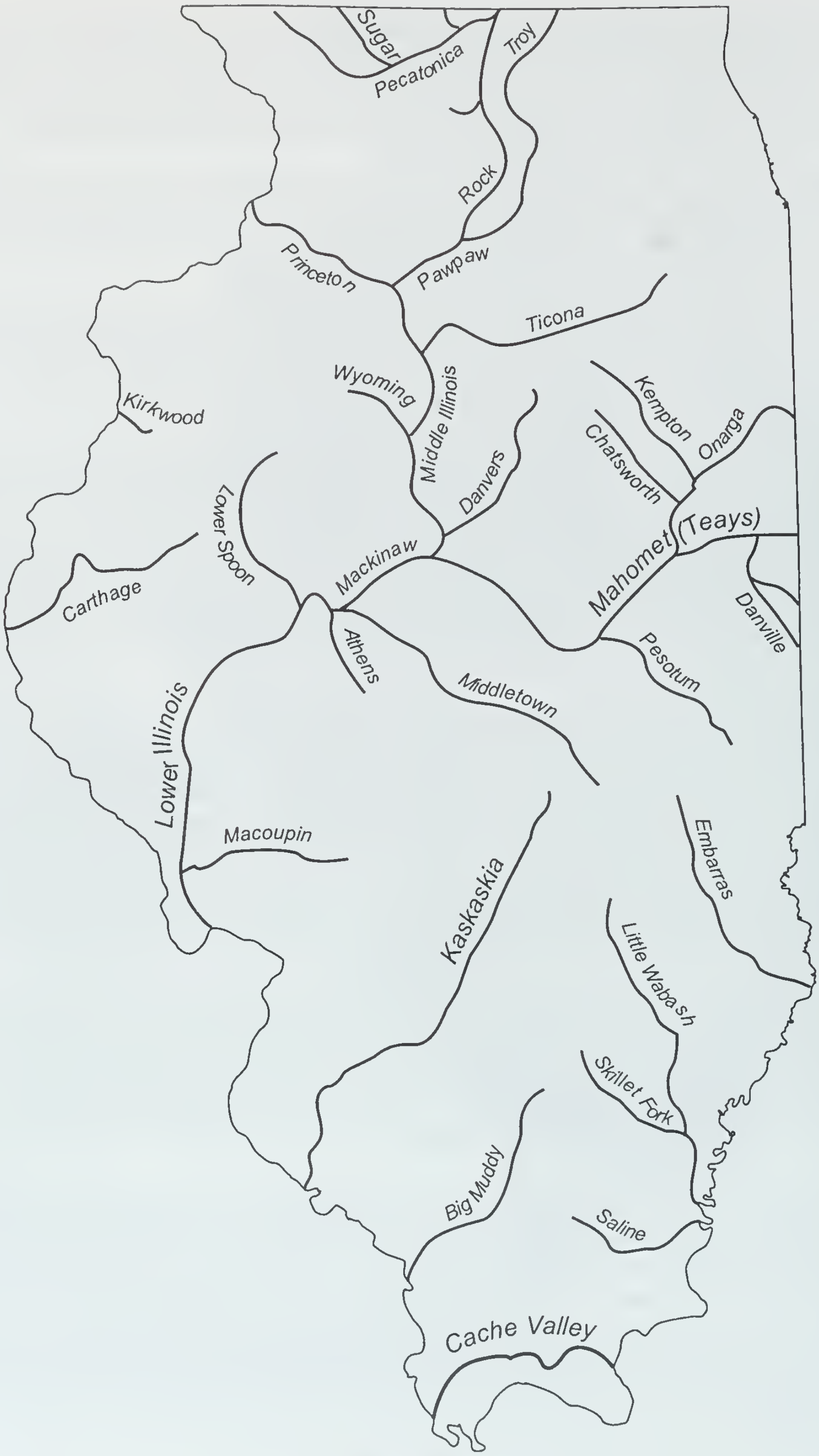


Figure 10 Generalized bedrock valleys of Illinois.

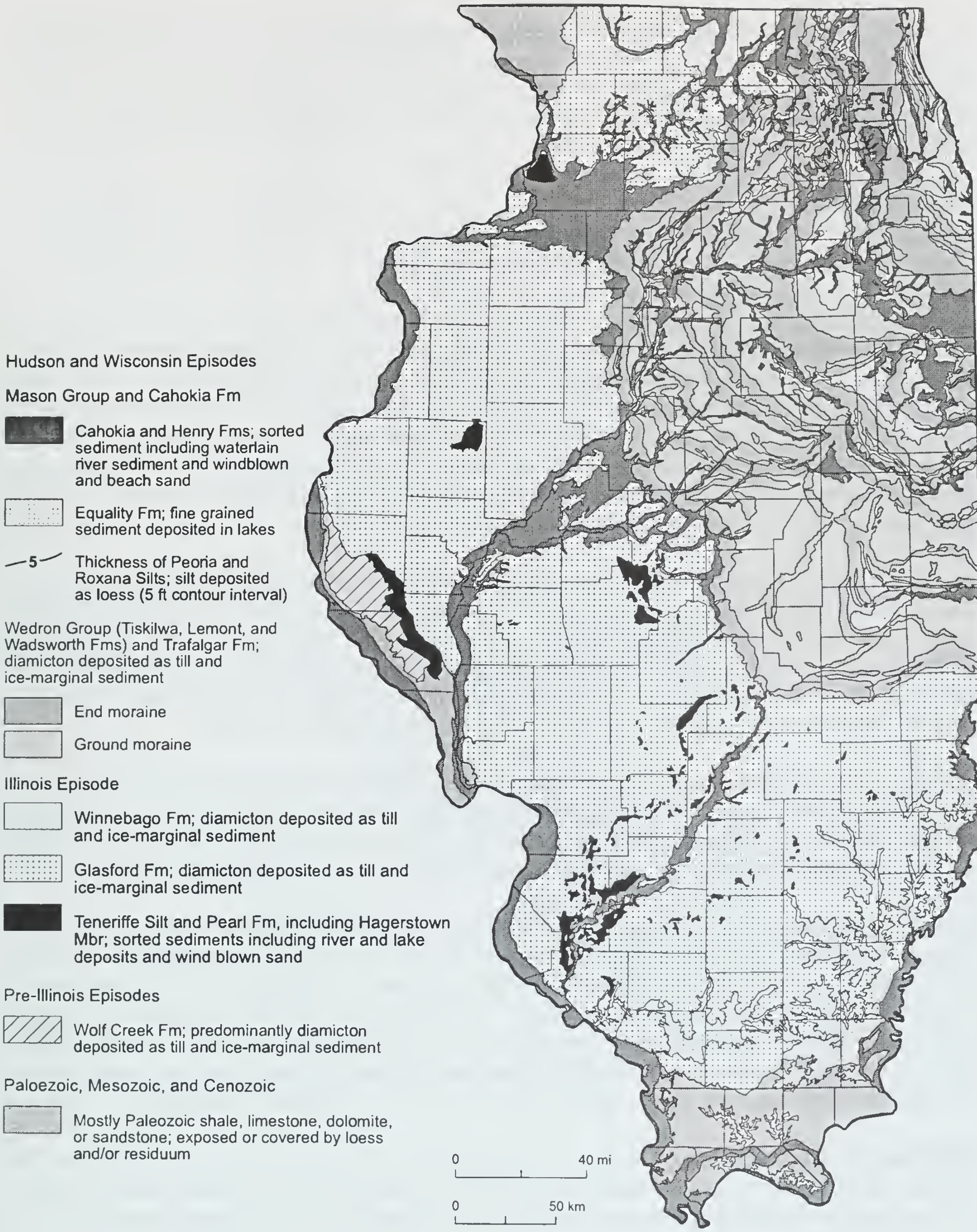


Figure 11 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

The soils in Winnebago County have developed in the loess, in windblown sand, in the underlying weathered silty, clayey Illinoian *till*, in the sand and gravel outwash deposits, and in the Ordovician dolomite (where exposed). Within the field trip area, the thickness of the glacial drift ranges from 0 feet, where it has been removed by erosion and bedrock is exposed, to more than 200 feet in the Rock, Pecatonica, and Sugar Bedrock Valleys.

GEOMORPHOLOGY

Physiography The field trip area is located within the Rock River Hill Country of the *Till Plains* Section of the Central Lowland Physiographic Province (fig. 12).

As glaciers advanced and retreated, the landscape was eroded, reshaped, and modified many times. Much of western Winnebago County has been subjected to considerable glacial erosion by ice and meltwater, which accounts for the patchy, irregular distribution of glacial deposits and bedrock exposures. The topography in western Winnebago County is controlled primarily by the bedrock. In northeastern Winnebago County, glacial drift on the uplands is locally more than 100 feet thick in many places, and the topography is primarily controlled by erosion. Drift thickness exceeds 200 feet in the Rock, Pecatonica, and Sugar Bedrock Valleys. The modern Rock, Pecatonica, and Sugar Rivers roughly parallel their ancient bedrock valleys (fig. 13).

Prior to glaciation, an extensive system of *bedrock valleys* was deeply entrenched in the bedrock surface of the Illinois Basin. As glaciation began, streams probably changed from erosion to aggradation; that is, their channels began to build up and fill in because the streams did not have sufficient volumes of water to carry and move the increased volumes of sediment (a process called alluviation). To date, no evidence indicates that the early fills in these preglacial valleys were ever completely flushed out of their channels by succeeding glacial meltwater torrents.

Drainage Within Winnebago County, drainage is controlled by the Rock River, the Kishwaukee River, the Pecatonica River, and the Sugar River and their tributaries. The Rock River flows from north to south through Winnebago County and is a major tributary to the Mississippi River. Sedimentary rocks of Ordovician age are exposed along the waterways throughout the field trip area.

Relief The highest land surface on the field trip route is in the northern half of Sec. 19, T28N, R11E, on the Durand Quadrangle near the intersection of Illinois Route 70 and Moate Road, where the surface elevation is slightly more than 910 feet above mean sea level (msl). The lowest elevation is about 710 feet above msl along the Rock River near Stops 3 and 4. The surface relief of the field trip area, calculated as the difference between the highest and lowest surfaces, is about 200 feet. *Local relief* is most pronounced along Willow Creek in Rock Cut State Park where the Ordovician dolomite forms sheer vertical bluffs that rise more than 40 feet above the creek.

NATURAL RESOURCES

Mineral Production Winnebago County ranked 58th among all Illinois counties in 1992 on the basis of the value of all minerals extracted, processed, and manufactured. Economic minerals currently mined in Winnebago County include dolomitic stone and sand and gravel.

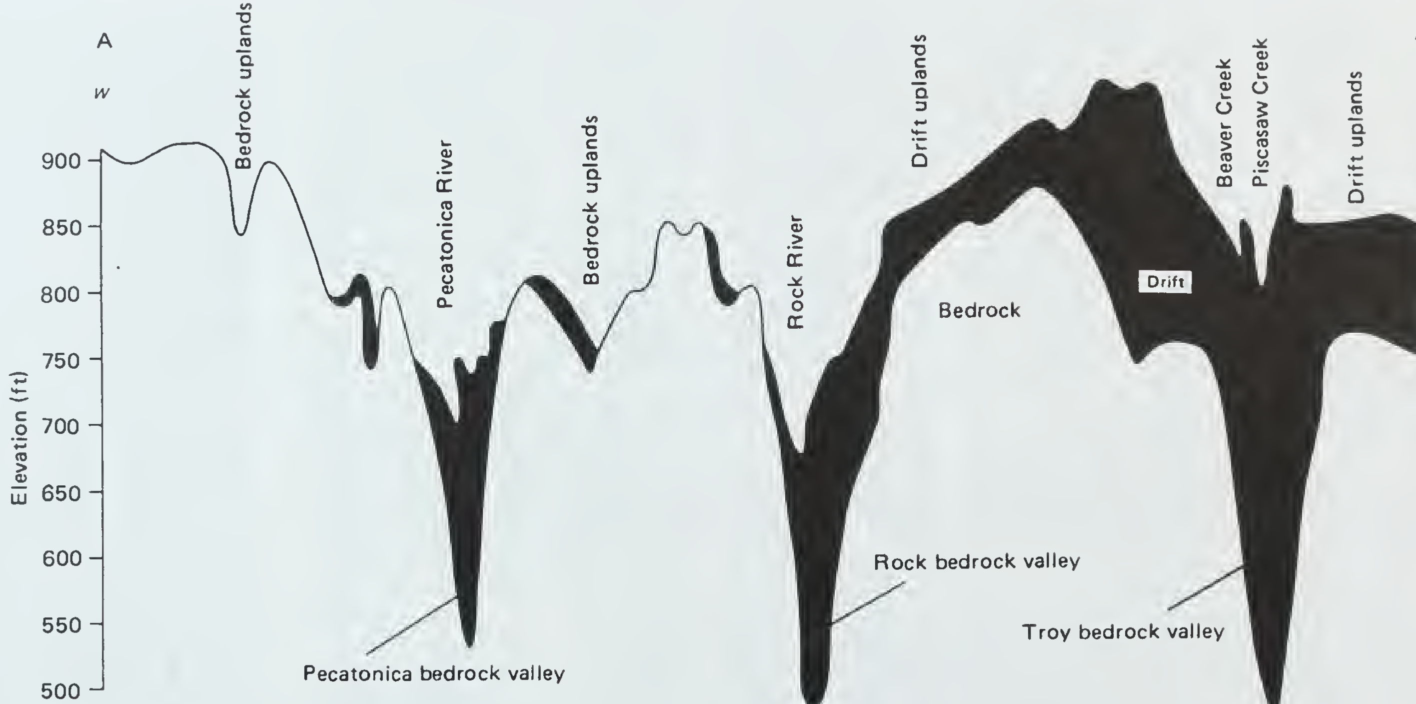
Most of the dolomite and limestone quarried in northern Illinois is used as aggregate for construction purposes. Other uses include agricultural lime and cement for concrete. Most domestic water wells in Winnebago and surrounding counties produce groundwater from fractures in the Platteville and Galena dolomite. The St. Peter Sandstone, which is mined at Oregon and Ottawa, Illinois, as a

Figure 12 Physiographic divisions of Illinois.

source of sand for making glass products, is exposed locally in the banks of the Sugar River in northwestern Winnebago County.

Groundwater Groundwater is a resource frequently overlooked in assessments of an area's natural resource potential. The availability of this resource is essential for orderly economic and community development. More than 35% of the state's 11.5 million citizens and 97% of those who live in rural areas depend on groundwater for their water supply. Groundwater is derived from underground formations called aquifers. The water-yielding capacity of an aquifer can only be evaluated by constructing wells into it. After construction, the wells are pumped to determine the quality and quantity of groundwater available for use.

In northern Illinois, groundwater resources are available from four major aquifers: (1) sand and gravel aquifers in the glacial drift, (2) the shallow dolomite aquifer, consisting of the Galena and



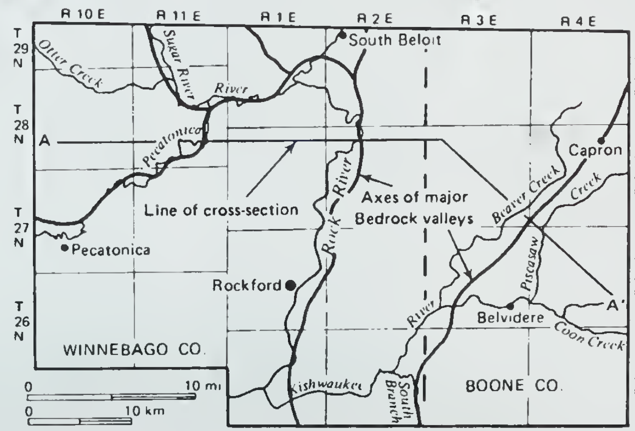


Figure 13 Generalized west–east cross section through Boone and Winnebago Counties showing relationship of bedrock topography to drift thickness, particulary in deep bedrock valleys (modified from Berg, Kempton, and Stecyk 1984).

Platteville Dolomite Groups, (3) sandstone aquifers consisting of the Glenwood–St. Peter and Ironton–Galesville Sandstones, and (4) the deeper Mt. Simon Aquifer, consisting of the Mt. Simon Sandstone and the basal sandstone (Elmhurst Member) of the Eau Claire Formation (fig. 2).

Groundwater is available throughout all of Winnebago County from one or more of the bedrock aquifers. Although the Galena–Platteville dolomite is probably the most widely used bedrock aquifer for domestic supplies, the deeper sandstones are the more dependable and predictable sources for larger quantities of groundwater.

The Galena and Platteville Groups constitute the uppermost bedrock throughout most of Winnebago County. Because of their widespread distribution, consistent water-yielding zones, and shallow position, these rocks provide water to more wells than does any other aquifer system in the county.

The St. Peter Sandstone, the Ironton–Galesville Sandstone, and the Elmhurst–Mt. Simon Sandstone are present throughout the county and furnish large quantities of water to the cities, villages, and industries within the county. Only the shallowest of these aquifers (the St. Peter Sandstone) is used for domestic groundwater supplies. The deeper sandstone aquifers are used only for larger municipal and industrial water supplies because deep well construction and maintenance costs are high.

The glacial drift aquifers consisting of outwash sand and gravel deposits are quite variable in their sorting, grain size, and thickness; however, any single outwash deposit is generally characterized by well-sorted, coarse sands and gravels that may yield large quantities of water. The principal glacial drift aquifers are generally limited to the major bedrock valleys, where the sand and gravel deposits are thickest.

Modern Geologic, Environmental, and Economic Studies in Winnebago County

In the early 1980s, the ISGS conducted a geologic mapping program for Winnebago and Boone Counties (Berg et al. 1984). Winnebago County, in particular, had experienced rapid population growth and accompanying environmental problems. It is still considered the county with the most vulnerable groundwater in Illinois. Sensitive sand and gravel and bedrock aquifers are at or near the surface, industrial development is extensive, and both Winnebago and Boone Counties have experienced problematic waste-disposal practices.

The program involved mapping both glacial deposits and bedrock. A stack-unit map was used to show the areal extent, vertical succession, and thickness of deposits in the upper 20 feet. Cross sections were used to show the entire thickness (several hundred feet thick in the Rock River valley) and continuity of glacial deposits from the surface to the top of bedrock. Small-scale maps were used to show the occurrence, thickness, and distribution of underlying bedrock units. Once the basic geology was understood and mapped, derivative maps were made that interpreted the geology for specific uses. These maps included interpretations for:

- Land burial of wastes
- Waste disposal by septic tank soil absorption systems
- General construction conditions
- Sand and gravel aquifers
- Thickness of bedrock aquifers

- Sand and gravel aggregate resources
- Peat resources
- Dolomite resources

This mapping program is unique because a follow-up investigation was conducted some 10 years after the mapping was completed to assess how the geologic information had been used to assess current environmental problems and to screen the county for land uses that could cause environmental problems in the future. This follow-up was in response to a state mandate requiring the ISGS to document the benefits and costs of geologic mapping (Bhagwat and Berg 1991). The original costs of the mapping project were well documented. The fiscal benefits derived from the availability of the basic and derivative maps were estimated based on future costs to society that could be avoided as a result of the knowledge gained through the mapping program. The benefit-cost study identified the following uses of the maps as well as measurable and nonquantifiable benefits:

- There were reduced costs for selecting waste-disposal sites, and for providing readily accessible and up-to-date information about geology, hydrology, and geologic material characteristics for use by county officials and consultants.
- There was improved confidence in the environmental decision-making process.
- Otherwise costly oversights, such as building subdivisions over buried peat bogs, were prevented.
- "Hot-spot" delineations were made, indicating areas where leaking underground storage tanks may be causing the most problems.
- Geologic information was used in classrooms, helping to create more "geologically enlightened citizens."
- Aggregate producers used the information to find deposits close to markets, while at the same time minimizing land use conflicts.
- Land use zoning and ordinances were developed to minimize septic-tank densities and restrict sewage sludge applications in sensitive terrains.
- Water-well drillers repeatedly used the maps for locating water supplies.

Estimates of avoidable costs were based on personal interviews with health and planning officials, private consultants, and industry representatives. Quantifiable benefit data were available only on part of the avoidable costs of cleaning up contaminated waste disposal and industrial activities. Based upon a $300,000 cost (in 1990 dollars) of the early 1980s mapping program and estimated avoidance costs of $1.4 to $16.3 million, the benefit-cost ratio for the mapping program ranged between 5:1 and 55:1.

Because the ISGS conducted a detailed three-dimensional mapping program in Winnebago County and the geology is so well known, the county was chosen to be part of a national testing program for detection of viruses and bacteria in groundwater. A pilot program for sampling four noncommunity wells was initiated in the summer of 1999. The objective of the study is to develop a more efficient method to detect bacterial and viral pathogens in drinking water using a new sampling-detection procedure recently developed by the American Waterworks Laboratory in Belleville, IL. In addition,

the ISGS will evaluate the relationship between wells that are contaminated with pathogens and the geologic environment in which the wells are situated.

Once this year-long project is complete, the ISGS wants to conduct its own research program on sources of waterborne pathogens and geology, perhaps using dedicated monitoring wells in various hydrogeologic settings and/or nested wells. This study will be designed to determine any seasonal effects on sampling (increased runoff and stormwater inputs), travel time from known sources to the wells, and the probability of getting a “detect” using a smaller sample (approximately 1 liter) with a greater sampling frequency.

GUIDE TO THE ROUTE

We'll start the trip in the parking lot for the swimming beach area of the Olson Lake Recreation Area at Rock Cut State Park. Assemble in the northern section of the parking lot. The parking lot is located in the NW, NW, SW, Sec. 25, T45N, R2E, 3rd P.M., Caledonia 7.5-Minute Quadrangle. Mileage will start at the west entrance/exit of the parking lot.

You must travel in the caravan. Please drive with headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs. If the road crossing is protected by an Illinois State Geological Survey (ISGS) vehicle with flashing lights and flags, please obey the signals of the ISGS staff directing traffic. When we stop, park as close as possible to the car in front of you and turn off your lights.

Private property Some stops on the field trip are on private property. The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips, follow these simple rules of courtesy:

- Do not litter the area.
- Do not climb on fences.
- Leave all gates as you found them.
- Treat *public* property as if you were the owner—which you are!
- Stay off of all mining equipment.
- Parents must closely supervise their children at all times.

When using this booklet for another field trip with your students, a youth group, or family, remember that *you must get permission from property owners or their agents before entering private property.* No trespassing please.

Seven USGS 7.5-Minute Quadrangle maps (Belvidere NW, Caledonia, Durand, Pecatonica, Rockford North, Shirland, and South Beloit) provide coverage for this field trip area.

Miles to next point	Miles from start	
0.0	0.0	Set your odometers to 0.0 at the west end of the parking lot. Exit parking lot and head south on the Olson Lake Recreation Area entrance/exit road. There are many bicycle trails and bicyclers in the park. Please use caution when driving through the park.
0.3	0.3	STOP (3-way). T-intersection from the right. TURN RIGHT toward campground as indicated on sign.
0.1	0.4	Cross bridge over the northwest tollway (Interstate 90).

0.1	0.5	STOP (3-way). TURN LEFT toward boat launch as indicated on sign. This is the main loop road around Pierce Lake at Rock Cut State Park.
0.1	0.6	Lions Club picnic area to the right. CONTINUE AHEAD.
0.4	1.0	Red Oak picnic area to the right. CONTINUE AHEAD.
0.4	1.4	Island View picnic area to the right. CONTINUE AHEAD.
0.1	1.5	Boat launch and concession area to the right. CONTINUE AHEAD.
0.5	2.0	West Lake picnic area. Park in one of the several parking lots in the area, but stay in line. Follow trail west of the shelter to Lone Rock.

STOP 1 Lone Rock – Rock Cut State Park The Galena dolomite forms the bluffs below the spillway along Willow Creek (northern half of the SW, Sec. 27, T45N, R2E, 3rd P.M., Caledonia 7.5-Minute Quadrangle).

0.0	2.0	Leave Stop 1 and CONTINUE AHEAD.
0.2	2.2	Cross spillway. View of Pierce Lake is to the right. To the left is the valley cut by Willow Creek.
0.1	2.3	Lake View picnic area to the left. CONTINUE AHEAD.
0.1	2.4	Entrance road to the Fishing Pier area is to the right. CONTINUE AHEAD.
0.1	2.5	T-intersection from the right. Entrance road to Hickory Hill Campground. CONTINUE AHEAD. Follow signs to Highway 173.
0.3	2.8	T-intersection from the left (Hart Road). TURN LEFT. Follow signs indicating Rock Cut State Park snowmobile and horse area.
0.4	3.2	T-intersection from the right. Entrance to the equestrian and snowmobile area. CONTINUE AHEAD.
0.55	3.75	Park boundary and intersection of Hart Road and Perryville Road. NOTE: Perryville Road is under construction. On the day of the field trip, we will park along Hart Road next to where the horse trails cross.

STOP 2 Perryville–Hart Road Exposure Exposure of the Mackinaw Member of the Henry Formation of Wisconsinan age in the hillside along the east side of Perryville Road at the edge of the park boundary (NW, NW, NE, Sec. 28, T45N, R2E, 3rd P.M., Rockford North 7.5-Minute Quadrangle). This sandy and gravelly outwash material forms the foundation for many of the gravel prairies along the east slope of the Rock River valley.

0.0	3.75	Leave Stop 2. Turn around and retrace the route back toward the main park road.
1.0	4.75	STOP (1-way). Intersection of Hart Road and the main park road. TURN LEFT.
0.35	5.1	Plum Grove area to the right is an Illinois Natural Preserve.

This natural area has been formally dedicated as a sanctuary for native vegetation and wildlife. It is maintained in a natural condition so that present and future generations can see the Illinois landscape as it appeared to pioneers. This living example of our natural heritage is also valuable for scientific studies in ecology, geology, soil science, and natural history and may provide habitat for rare plants and animals. Visitors are welcome, but please protect and perpetuate the area by not disturbing or removing anything. All natural features are protected by the law.

—Illinois Department of Natural Resources,
Illinois Nature Preserve Commission

0.3	5.4	STOP (2-way). CONTINUE AHEAD. Follow signs to park exit and Route 173. NOTE: The road to the right leads you along the northern loop of the main park road.
0.1	5.5	Passing through a restored native prairie in Rock Cut State Park.
0.6	6.1	STOP (1-way). T-intersection (Illinois Route 173 and Park Entrance). TURN LEFT.
0.75	6.85	Roadside picnic area to the right.
0.05	6.9	T-intersection from the right (Mitchell Road). TURN RIGHT (heading north).
1.3	8.2	T-intersection from the left (Willow Brook Road). CONTINUE AHEAD.
0.5	8.7	STOP (1-way). T-intersection (Swanson Road). TURN RIGHT.
0.2	8.9	T-intersection from the left (McDonald Road). TURN LEFT.
1.5	10.4	STOP LIGHT. Intersection of McDonald Road and Illinois Route 251. CONTINUE AHEAD, cross Route 251, and TURN LEFT onto Frontage Road (heading south).

1.01	11.4	STOP (3-way). TURN RIGHT. Entrance to Rockford Sand and Gravel, North Shore Plant.

STOP 3 Rockford Sand and Gravel Co., North Shore Plant (SE, NE, Sec. 8 and SW, NW, Sec. 9, T45N, R2E, 3rd P.M., South Beloit 7.5-Minute Quadrangle). On the day of the trip, follow the lead vehicle into the sand and gravel operation. We will examine the dredging operation and the Rock River valley outwash deposits of the Mackinaw Member of the Wisconsinan-age Henry Formation.

0.0	11.4	Leave Stop 3. TURN LEFT onto the frontage road, and retrace the route back toward McDonald Road.
0.8	12.2	STOP (2-way). T-intersection (frontage road and McDonald Road). TURN RIGHT.
0.05	12.25	STOP LIGHT (intersection of McDonald Road and Illinois Route 251). TURN LEFT onto Illinois Route 251 (heading north). NOTE: Route 251 is a divided highway. Stay in the left-hand lane after making the turn onto Route 251.
0.45	12.7	Approaching Bridge Street intersection.
0.15	12.85	STOPLIGHT (intersection of Bridge Street and Illinois Route 251). TURN LEFT onto Bridge Street (this is Winnebago County Road 63).
0.1	12.95	Entrance to Riverside Park is to your right. CONTINUE AHEAD.
0.05	13.0	Cross Rock River.
0.4	13.4	T-intersection from the left (Gleasman Road). TURN LEFT. This is Winnebago County Road 71 (heading south). We are driving across the floodplain of the Rock River.
0.55	13.95	Road makes a 90° turn to the right and then a 45° turn to the left.
0.35	14.3	Road makes a 90° turn to the right.
0.2	14.5	T-intersection from the left (Brenda Drive). CONTINUE AHEAD.
		Directly ahead are the bluffs that form the western edge of the Rock River valley. These bluffs consist of Ordovician dolomite overlain by the glacial tills of the Illinoian-age Winnebago Formation.
0.7	15.2	Passing under the Chicago, Milwaukee, St. Paul, and Pacific Railroad trestle, as noted on the 1971 quadrangle map. Just past the railroad trestle, the road starts to ascend the west slope of the Rock River valley.
0.2	15.4	Prairie Ridge housing development on the left. This is an example of the many housing developments in northeastern Illinois located outside of the large met-

ropolitan areas. This expansion of large housing developments is commonly referred to as "urban sprawl."

0.45	15.85	STOP (4-way). Crossroad intersection of Gleasman Road and Old River Road. TURN LEFT (heading south).
0.25	16.1	Another housing development on the right and a golf course on the left.
0.7	16.8	T-intersection from the left entrance to Winnebago County Forest Preserve District, Atwood Homestead Forest Preserve and Golf Course, established in 1963. TURN LEFT.
0.75	17.55	STOP (3-way). T-intersection. TURN RIGHT and pass under the railroad trestle. To the left is the clubhouse and golf course and to the right are the boat ramp, shelters, and picnic area.
0.1	17.65	TURN LEFT and enter the parking area of the River Oaks shelter.

STOP 4: LUNCH Atwood Homestead Forest Preserve (NW, NW, SE, Sec. 7, T45N, R2E, 3rd P.M., South Beloit 7.5-Minute Quadrangle).

0.0	17.65	Leave Stop 4. Retrace your route back to the entrance and Old River Road.
0.85	18.5	STOP (1-way). T-intersection with forest preserve entrance road and Old River Road. TURN RIGHT (heading north) on Old River Road.
0.9	19.4	STOP (4-way). Crossroad intersection of Old River Road and Gleasman Road. TURN LEFT onto Gleasman Road; this is Winnebago County Road 71.
1.0	20.4	STOP (2-way). Crossroad intersection of North Main Street and Gleasman Road. TURN RIGHT (heading north) on North Main Street; this is North Illinois Route 2.
1.0	21.4	Crossroad intersection of Roscoe Road and North Main Street. TURN LEFT; this is Winnebago County 63 (heading west).
0.95	22.35	STOP (2-way) from right and left. Crossroad intersection of Roscoe Road and Rockton Avenue. CONTINUE AHEAD.
0.25	22.6	Crossing the second highest point of elevation on the field trip route, 900 feet above sea level (see route map). This point offers a great view of the Pecatonica River valley located to the north and west.
0.3	23.3	STOP (1-way). T-intersection of Owen Center Road and Roscoe Road. TURN RIGHT (heading north); this is Winnebago County Road 13.
0.4	23.7	Good view of the Pecatonica River valley to the north.

0.1	23.8	T-intersection to the right (Moffett Road). CONTINUE AHEAD. In the distance to the right is a stockpile of dolomite from a new quarry.
0.9	24.7	Approaching Freeport Road/Illinois Route 75.
0.1	24.8	STOP (1-way). T-intersection of Freeport Road with Illinois Route 75. TURN LEFT. CAUTION: Fast moving traffic. Head west on Illinois Route 75.
0.6	25.4	The trees to the right are growing along an old oxbow lake of the Pecatonica River (see route map).
0.3	25.6	T-intersection from the left (Gummow Road). CONTINUE AHEAD.
0.8	26.5	T-intersection from the left (Bates Road). CONTINUE AHEAD.
1.0	27.5	Cross Timothy Creek.
0.3	27.8	Crossroad intersection (Meridian Road and Freeport Road). CONTINUE AHEAD. The intersection of Meridian and Freeport Roads is located approximately in the middle of the Pecatonica River floodplain.
0.7	28.5	Entering the community of Harrison.
0.2	28.7	T-intersection from the left (Harrison Road). CONTINUE AHEAD. Approaching the Pecatonica River.
0.15	28.85	Cross the Pecatonica River and prepare to turn right.
0.1	28.95	T-intersection from the right (Harrison Road). TURN RIGHT onto Harrison Road (heading north). CAUTION: Harrison Road is a narrow 2-lane blacktop. The Pecatonica River along this stretch flows south to north.
0.15	29.1	Two Rivers Forest Preserve (est. 1979) is another Winnebago County Forest Preserve. We are heading north on Harrison Road toward the town of Shirland, where the Pecatonica River makes a sharp 90°-degree bend and starts flowing to the east toward Rockton and the Rock River. South of Harrison, the Pecatonica River flows west to east through a large number of meanders in the old river valley (see route map).
0.2	29.3	The Pecatonica River is to the right. One-lane bridge ahead.
0.2	29.5	Cross Tulip Bridge. The Sugar River, from the left, flows eastward under the bridge and enters the Pecatonica River, to the right.
0.3	29.8	View of the Sugar River valley to the left.
0.15	29.95	Entering the community of Shirland.
0.15	30.1	STOP (1-way). T-intersection (North Street and Mitchell Street). TURN RIGHT. After making the turn, the Shirland Town Hall (est. 1902) is on the left.

0.15	30.25	T-intersection from the left (Boswell Road). TURN LEFT (heading north).
1.3	31.55	STOP (2-way). Crossroad intersection (Forest Preserve Road and Boswell Road). CONTINUE AHEAD.
0.4	31.95	Entrance to Austin Quarry on your right. TURN RIGHT.

STOP 5 Austin Quarry (SE, NW, SE, Sec. 35, T29N, R11E, 4th P.M., Shirland 7.5-Minute Quadrangle). We will examine the Ordovician-age Galena and Platteville dolomites.

0.0	31.95	Leave Stop 5 and TURN RIGHT.
0.55	32.5	Stop (1-way). Intersection of Yale Bridge Road and Boswell Road. Turn LEFT (heading west).
1.5	34.0	T-intersection to the right (Hauley Road). TURN RIGHT.
0.5	34.5	T-intersection from the left (Hass Road). TURN LEFT.
1.1	35.6	Entrance to Colored Sands Forest Preserve (est. 1976). TURN LEFT into the parking lot. This is also the location of the Sand Bluff Bird Observatory and banding station.

STOP 6 Colored Sands Forest Preserve (NE, SE, Sec. 29, T29N, R11E, 4th P.M., Shirland 7.5-Minute Quadrangle). Park in the parking lot, but please stay in formation. Follow the trail located left of the visitors center to the overlook of the Sugar River. We will examine an exposure of windblown St. Peter Sandstone that forms a large dune in this area.

0.0	35.6	Leave Stop 6. At the exit, TURN RIGHT and head east onto Haas Road.
1.1	36.7	STOP (1-way). T-intersection of Hass Road and Hauley Road. TURN RIGHT.
0.5	37.2	STOP (2-way). Crossroad intersection (Hauley Road and Yale Bridge Road). TURN RIGHT.
0.1	37.3	Outcrop of Ordovician Platteville dolomite to the left, and a small quarry to the right.
1.0	38.3	Southern entrance to Colored Sands Forest Preserve. Parking area with restroom facilities. CONTINUE AHEAD.
0.1	38.4	Cross the Sugar River. Wooded wetlands are on both sides of the road after you cross the Sugar River. This wetland is on the Sugar River floodplain.
0.6	39.0	T-intersection from the right (unnamed). CONTINUE AHEAD.

0.1	39.1	View to the right and left of the flat floodplain of the Sugar River. Average elevation is 740 feet. Directly ahead, to the west, is a view of the bluffs that form the western wall of the Sugar River valley.
0.6	39.7	Road ascends the west slope of the Sugar River valley. Note the Ordovician-age outcrop on the right side of the road, just at the top of the bluff .
0.55	40.25	STOP (4-way). Crossroad intersection of Wheeler Rodd/Winnebago County 23 with Yellow Bridge Road/Winnebago County 48. TURN LEFT (heading south).
0.45	40.7	Crossroad intersection (Tallakson Road and Wheeler Road). CONTINUE AHEAD. Notice the soil in this part of Winnebago County compared to the soil at Stop 2. The soil here is very sandy and only a small number of glacial erratics are evident. The soil at Stop 2 consisted of a large mixture of sand, gravel, and boulders. Each soil was developed from a different parent material.
0.5	41.2	Crossroad intersection (Baker Road). CONTINUE AHEAD.
0.45	41.65	Cross Otter Creek, a small tributary of the Sugar River. The Sugar River flows into the Pecatonica River, which in turn flows into Rock River, which eventually enters the Mississippi River near Rock Island, Illinois. Ultimately, the soil, sand, and rocks in Otter Creek will travel all the way to New Orleans and the Gulf of Mexico.
0.6	42.25	Cross abandoned railroad grade of the Chicago, Milwaukee, St. Paul, and Pacific Railroad.
0.35	42.6	Crossroad intersection (Fritz Road). CONTINUE AHEAD.
1.0	43.6	STOP (2-way). Crossroad intersection of Wheeler Road with Freeport Road/Illinois Route 75. TURN LEFT (heading east on Illinois Route 75). The outcrop to the right of the intersection is the Ordovician-age Galena Group. The Galena Group contains a fossil blue-green algae called *Receptaculites*, an index fossil.
0.7	44.3	Crossroad intersection (Moate Road). TURN RIGHT (heading south); this is Winnebago County 23. The highest elevation along the field trip route, 910 feet above sea level, is at this intersection. This high point is part of a east–west ridge that defines a local drainage divide. All of the drainage north of this divide flows toward the Sugar River, and drainage south of this divide flows toward the Pecatonica River (see route map.)
0.5	44.8	Crossing a small creek, which flows to the Pecatonica River.
0.2	45.0	Bethel Cemetery is on the left.
0.1	45.1	Crossroad intersection (Farm School Road). CONTINUE AHEAD.
0.6	45.7	Crossing Hungry Run Creek, which flows to the Pecatonica River.

0.3	46.0	Crossroad intersection (Campbell Road). CONTINUE AHEAD.
0.3	46.3	Crossing a small creek, which flows to the Pecatonica River.
0.7	47.0	STOP (1-way). T-intersection (Task Bridge Road/ Illinois Route 70 and Moate Road). The Pecatonica River is straight ahead. TURN RIGHT.
0.2	47.2	View of the quarry is straight ahead and to the right of the road.
0.5	47.7	Entrance to Rockford Sand and Gravel Company, Farm Quarry. TURN RIGHT.

Directly across from the quarry is a wildlife observation pull-off, which was constructed by Rockford Sand and Gravel.

The monument, dedicated by the employees of Rockford Blacktop Construction in memory of Bill Howard, Sr. 1911–1987, bears a version of a popular poem by Will Allen Dromgoole (?1860–1934):

The Bridge Builder

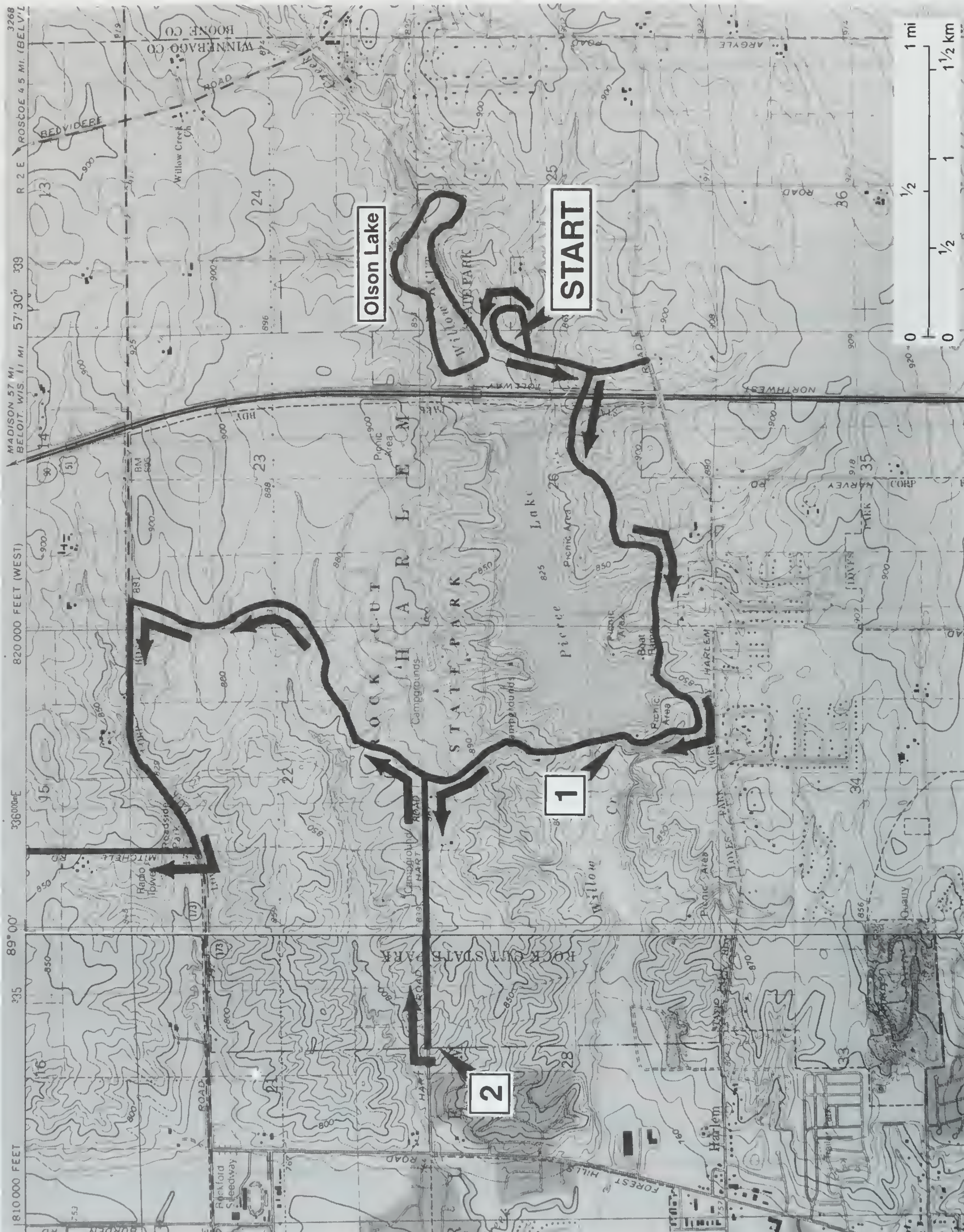
An old man going a lone highway
Came in the evening cold and gray
To a chasm vast and deep and wide
Through which was flowing a sullen tide.
The old man crossed in the twilight dim;
The swollen stream held no fears for him;
But he turned when safe on the other side
And built a bridge to span the tide.

"Old man," said a fellow pilgrim near,
"You are wasting your strength with building here;
Your journey will end with the ending day;
You never again must pass this way;
You have crossed the chasm deep and wide—
Why build you this bridge at eventide?"

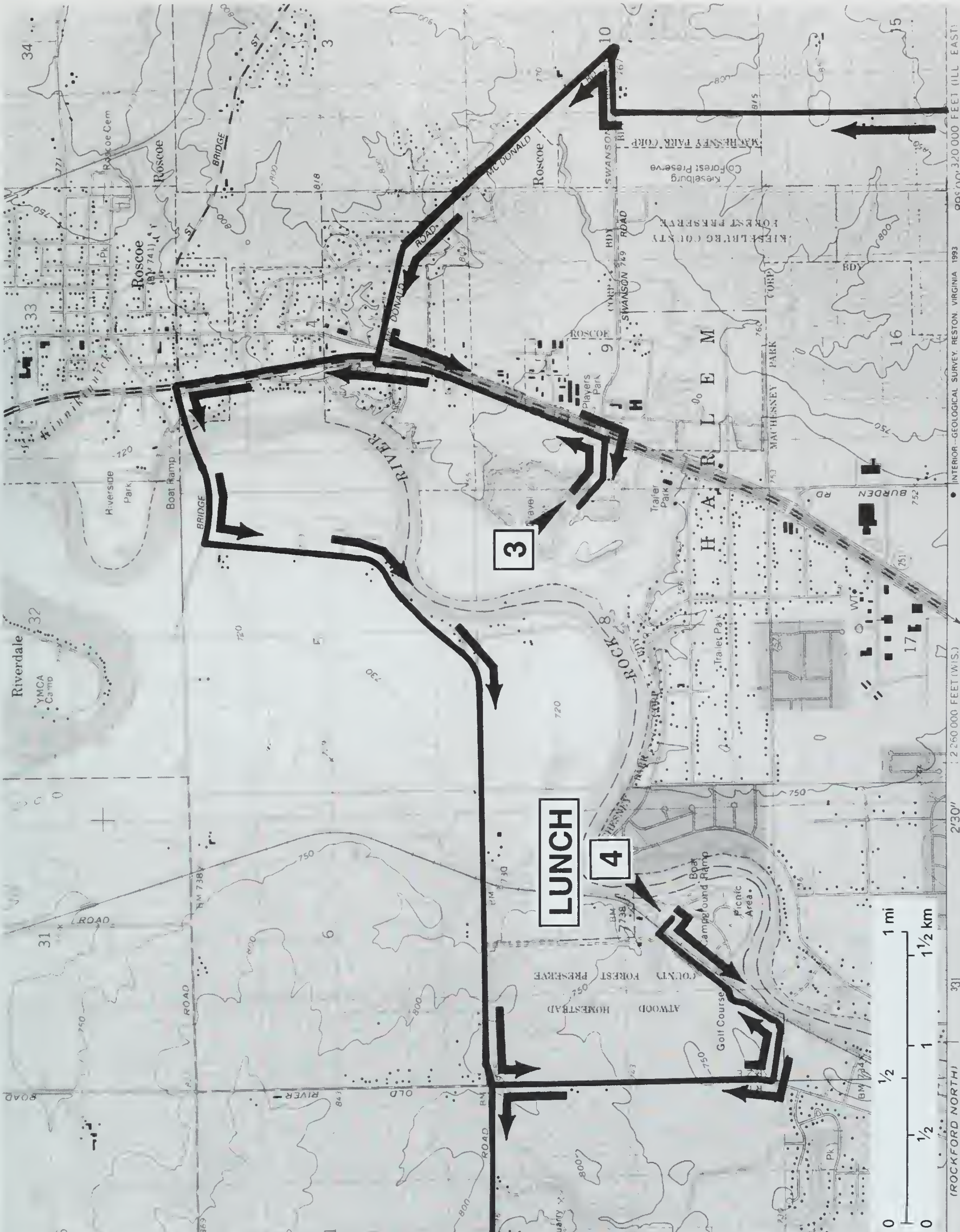
The builder lifted his old gray head.
"Good friend, in the path I have come," he said,
"There follows after me today
A youth whose feet must pass this way.
This swollen stream which was naught to me
To that fair-headed youth may a pitfall be;
He, too, must cross in the twilight dim;
Good Friend, I am building the bridge for him!"

STOP 7 Rockford Sand and Gravel Company, Farm Quarry (SE, Sec. 36, T28N, R10E, 4th P.M., Durand 7.5-Minute Quadrangle). We will examine the Ordovician-age Platteville dolomite.

END OF TRIP. Have a safe ride home! To reach the Rockford area from the quarry, TURN LEFT and follow Route 70 all the way to Meridian Road. TURN RIGHT onto Meridian Road and head south to U.S. 20. HEAD EAST on U.S. 20, which will take you to Interstates 39 and 90.



Olson Lake
START
1
2
ROCK CUT STATE PARK
Pierce Lake
0 ½ 1 mi
0 ½ 1 1½ km


LUNCH
3
4
Roscoe
Riverdale
YMCA Camp
Riverside Park
Boat Ramp
ROCK RIVER
Kieselburg Co Forest Preserve
ATWOOD HOMESTEAD COUNTY FOREST PRESERVE
Golf Course
Picnic Area
Campground
Trailer Park
Players Park
MACHESNEY PARK
HARLEM
MC DONALD ROAD
SWANSON ROAD
BURDEN RD
1 mi
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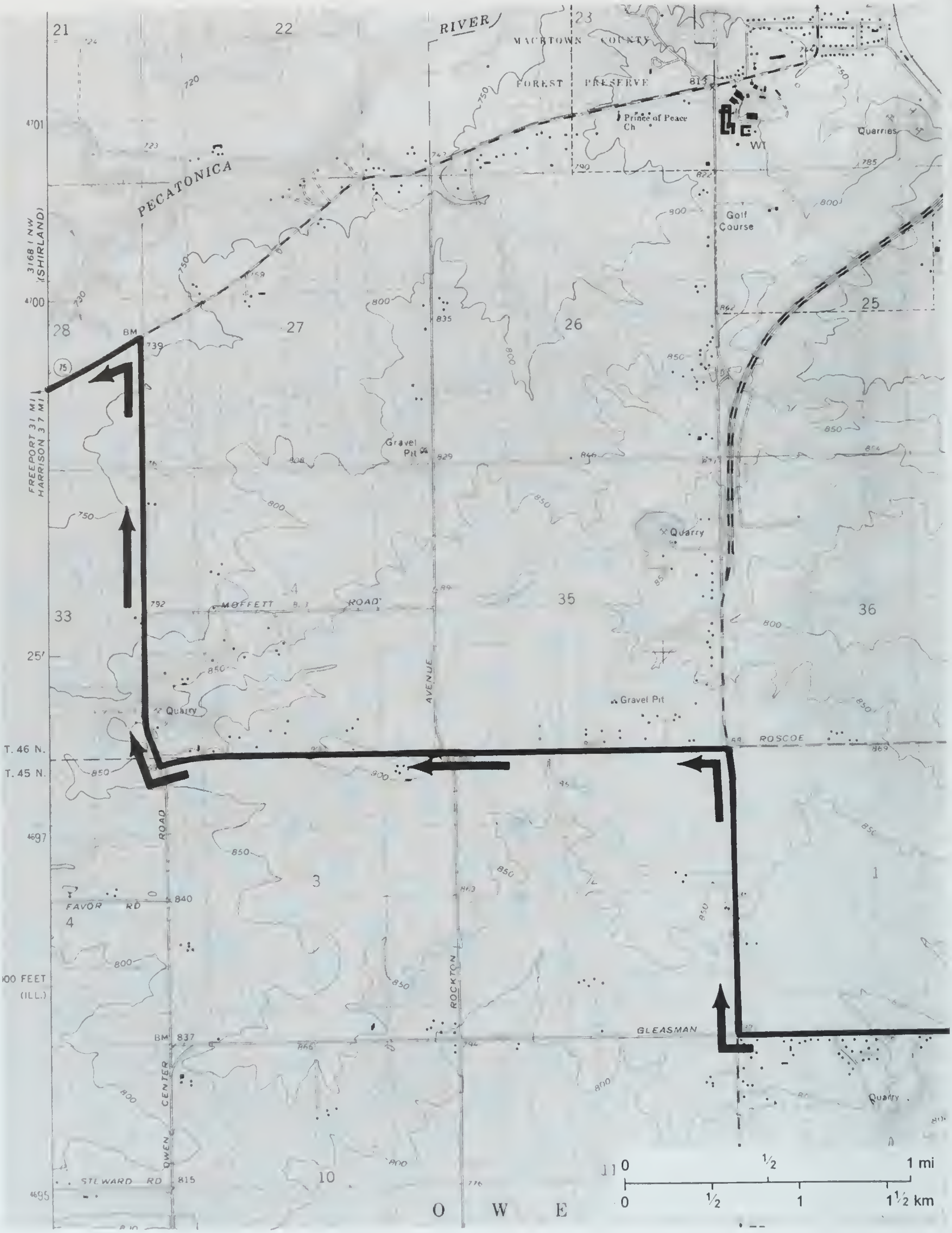
(ROCKFORD NORTH) 3168 I SE
INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA 1993



RIVER
MACKTOWN COUNTY
FOREST PRESERVE
Prince of Peace Ch
Quarries
Golf Course
PECATONICA
3168 I NW (SHIRLAND)
FREEPORT 31 MI
HARRISON 3.7 MI
Gravel Pit
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MOFFETT ROAD
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ROSCOE
Gravel Pit
T. 46 N.
T. 45 N.
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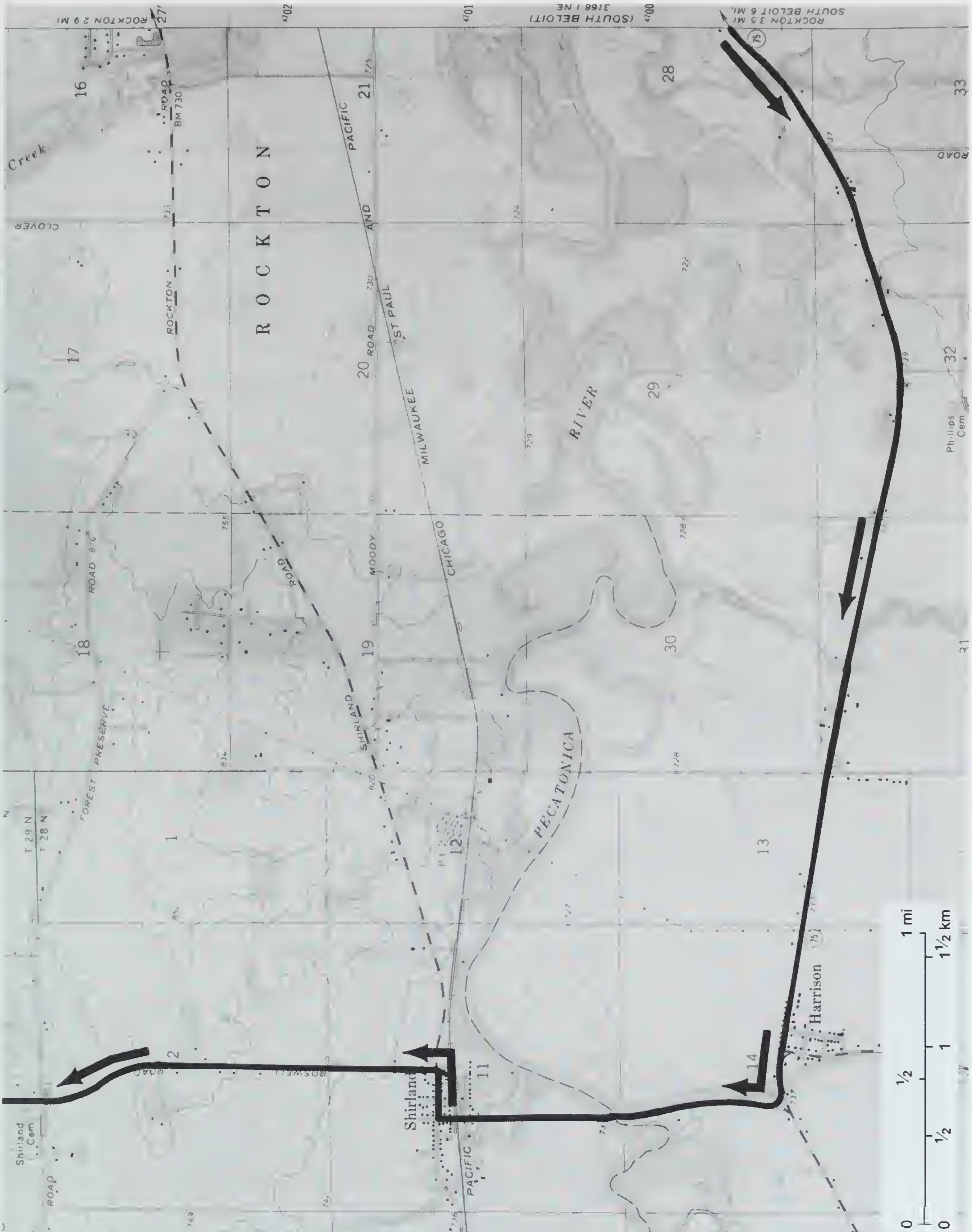
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SOUTH BELOIT 6 MI.
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(SOUTH BELOIT)
3168 I NE
Shirland
Harrison
PECATONICA
RIVER
CHICAGO
MILWAUKEE
ST PAUL
AND
PACIFIC
FOREST PRESERVE
Phillips Cem
Shirland Cem
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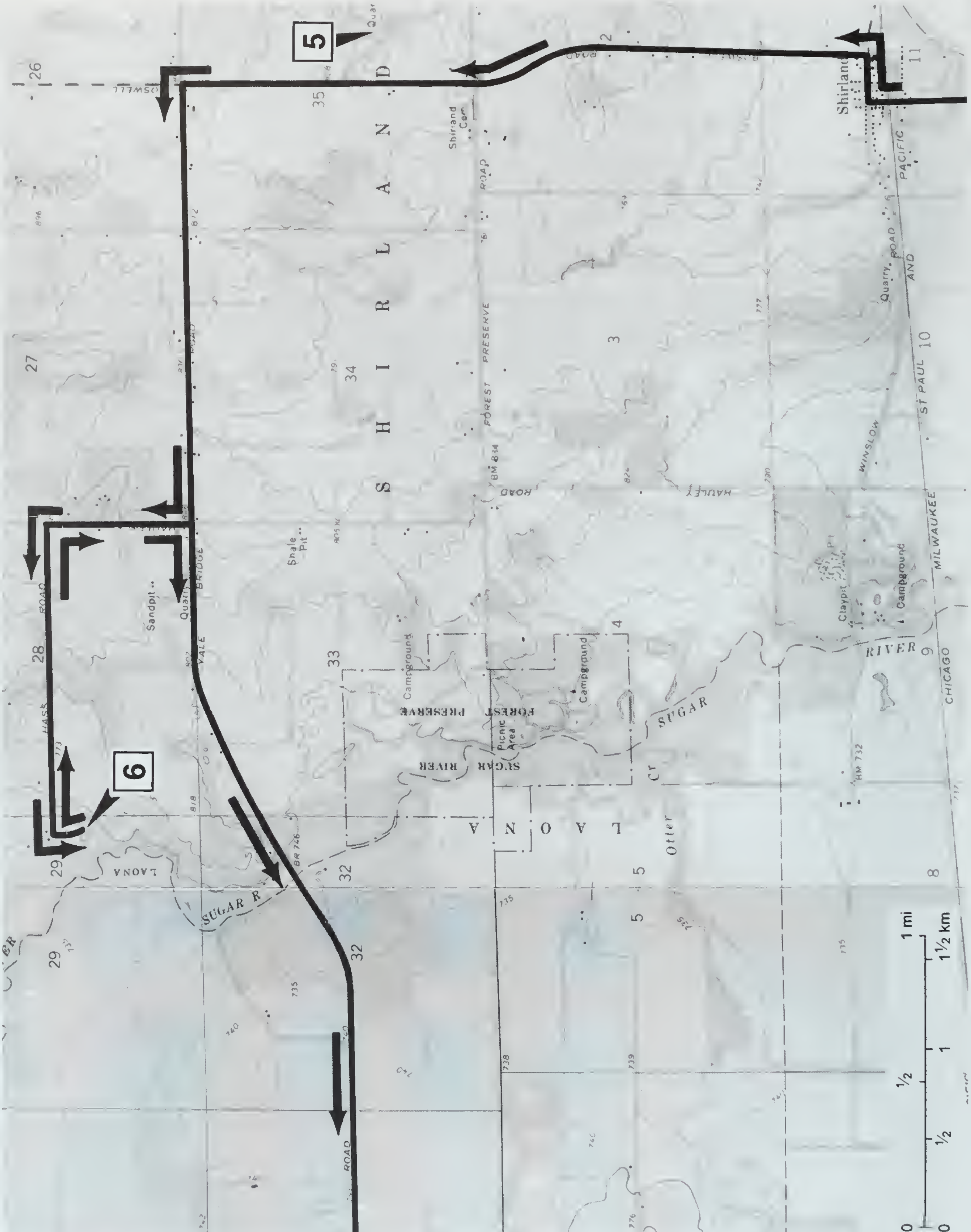
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6
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SUGAR RIVER FOREST PRESERVE
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CHICAGO MILWAUKEE ST PAUL AND PACIFIC
WINSLOW ROAD
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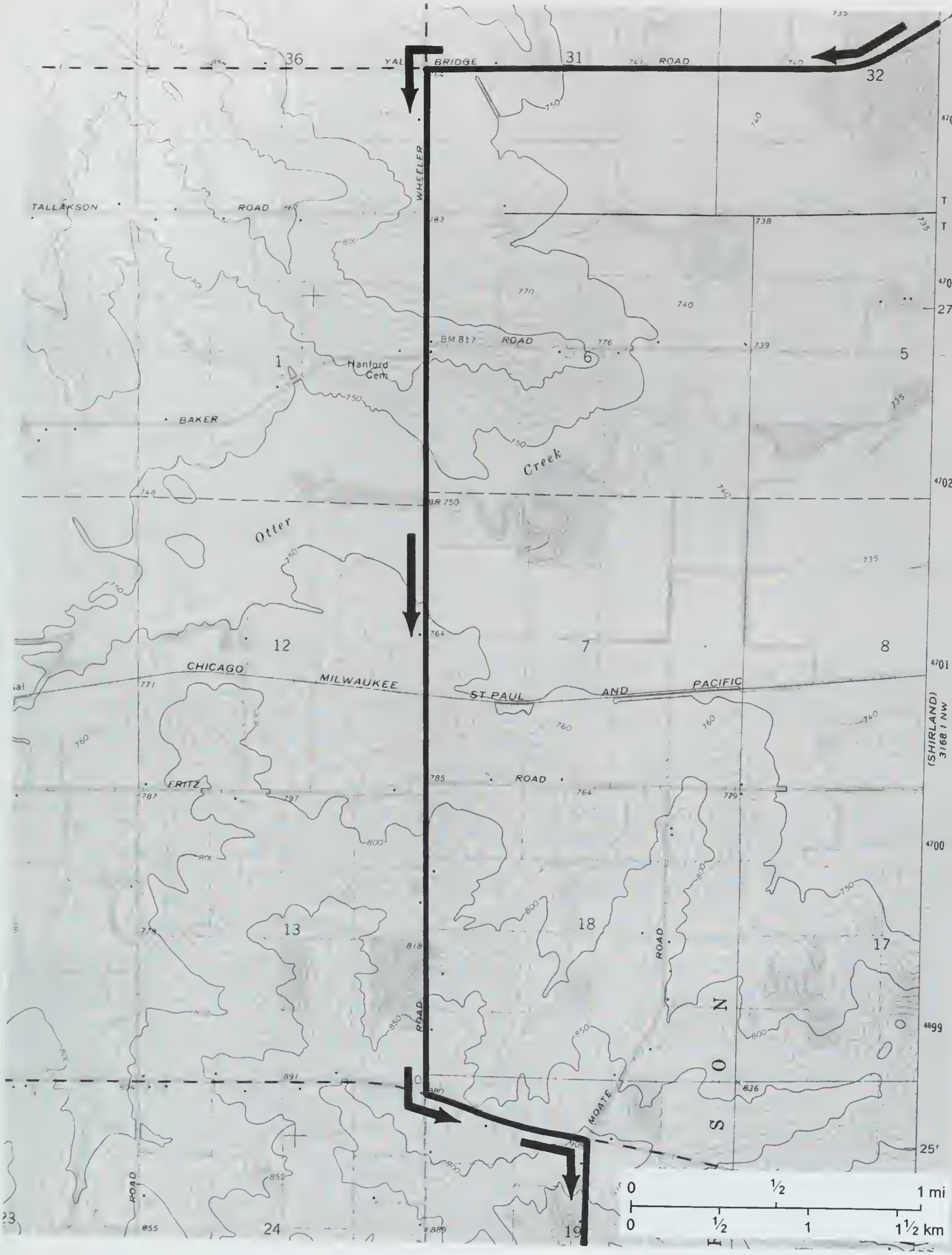

YALE BRIDGE
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27'30"
BM 817
ROAD
Hanford Cem
BAKER
Creek
Otter
BR 750
12
7
8
CHICAGO
MILWAUKEE
ST PAUL
AND
PACIFIC
(SHIRLAND) 3168 I NW
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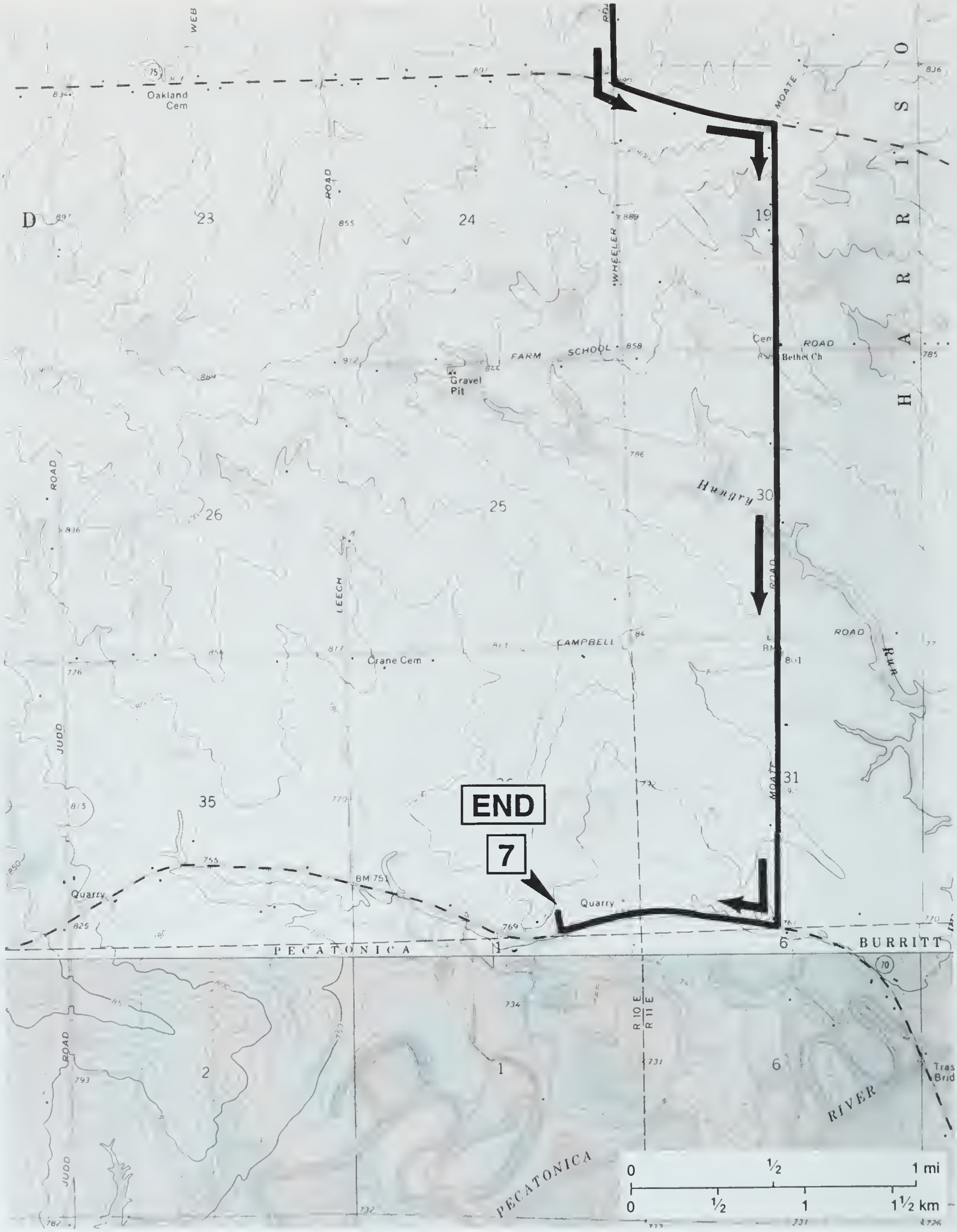
END
7
Oakland Cem
WEB
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FARM SCHOOL ROAD
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CAMPBELL
Crane Cem
JUDD ROAD
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Quarry
BM 751
PECATONICA
BURRITT
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STOP 1 Lone Rock – Rock Cut State Park.

STOP DESCRIPTIONS

STOP 1 Lone Rock – Rock Cut State Park (northern half of the SW, Sec. 27, T45N, R2E, 3rd P.M., Caledonia 7.5-Minute Quadrangle.

Rock Cut State Park

Chiseled out of the state's far northern region is Rock Cut State Park in Winnebago County. Nearby are other "rocky" landmarks—the mighty Rock River and the place where wagons once forded it, Rockford. It's an area of rolling plains, interesting history, and recreational variety.

Two lakes set off the park's 3,092 acres. Pierce Lake, with 162 acres, is a retreat for people wanting to fish, ice fish, or ice skate. A second 50-acre Olson Lake is especially for swimmers. Rounding out the park's recreational options are camping, hiking, horseback trails, cross-country skiing, and snowmobiling. Whatever the season, you can be sure there's quite a bit of activity going on at Rock Cut State Park.

The Park's Past By the middle of the 17th century, Miami-speaking tribes of Native Americans entered the region of Rock Cut State Park after the Iroquois drove them from territory on the southern end of Lake Michigan. From about 1655 until 1735, the Rock River was within the range of the Mascouten, who were also pushed westward by the Iroquois. The Winnebago ranged southward from Wisconsin to the Rock River from the 1740s until 1837, while the river's upper portion was on the periphery of the Fox and Sauk territory from about 1765 to 1833. By 1800, the Potawatomi, Ottawa,

and Chippewa nations had extended their range into the area, but they ceded their lands to the United States 32 years later following the Black Hawk War.

Settlement of Winnebago County began after the Black Hawk War. The region that is now Rock Cut State Park was settled partly by Scots around Argyle—named for their Scottish home of Argyllshire—and partly by Canadians, New Yorkers, and New Englanders around the town of Harlem. The Illinois version of Harlem was moved in 1859 when the Kenosha–Rockford Rail Line was built. The dammed waters of Pierce Lake now cover much of the railroad bed within the park, although portions of the railroad grade are visible along Willow Creek below the spillway. But blasting operations in a rock outcrop that railroad crews conducted during the 1859 construction left lasting impressions here—they cut through rock to provide a suitable roadbed and gave Rock Cut its name.

—Reprinted from DNR park brochure

Geologic Features

Galena dolomite forms the bluffs below the spillway along Willow Creek. Lone Rock is the large, solitary, triangular block of Galena dolomite located east of the spillway along Willow Creek within Rock Cut State Park. The block was formed by the erosion of streams that followed intersecting fractures (joints) in the Galena dolomite.

Galena Formation (figs. 2 and 7a) The dolostone (dolomite) along the southern wall of Willow Creek valley is at least 60 feet thick. The lower portion is thick bedded and contains chert bands. The dolostone is part of the Ordovician System, the upper portion of the Galena Group. The dolomite was excavated over 50 years ago from an old abandoned quarry located within the park in the southwest corner of Section 27, and just north of Harlem Road.

The Galena Group was named for the town of Galena, Jo Daviess County, Illinois. It is the uppermost group of the Mohawkian Series in the Mississippi Valley and consists of strata from the base of the Spechts Ferry Formation to the top of the Dubuque Formation. The Galena Group normally overlies the Platteville Group and is overlain by the Maquoketa Group of the Cincinnatian Series. On the flanks of the Ozark Uplift, the Galena overlaps older formations and is, in turn, truncated by Maquoketa and younger formations. The Galena Group has a varied fossil fauna, including the famous *Receptaculites oweni,* a fossil blue-green algae.

STOP 2 Perryville–Hart Road Exposure (NW, NW, NE, Sec. 28, T45N, R2E, 3rd P.M., Rockford North 7.5-Minute Quadrangle)

The glacial material exposed at this stop belongs to the Argyle Till of the Winnebago Formation of Wisconsinan age and is underlain by sand and gravel named the Beaver Creek Gravel. This sandy and gravelly material forms the foundation for many of the gravel prairies along the eastern side of the Rock River valley. A west–east cross section of the Rock River valley is given in figure 14. This cross section represents what the Rock River valley looks like 2 miles south of this stop.

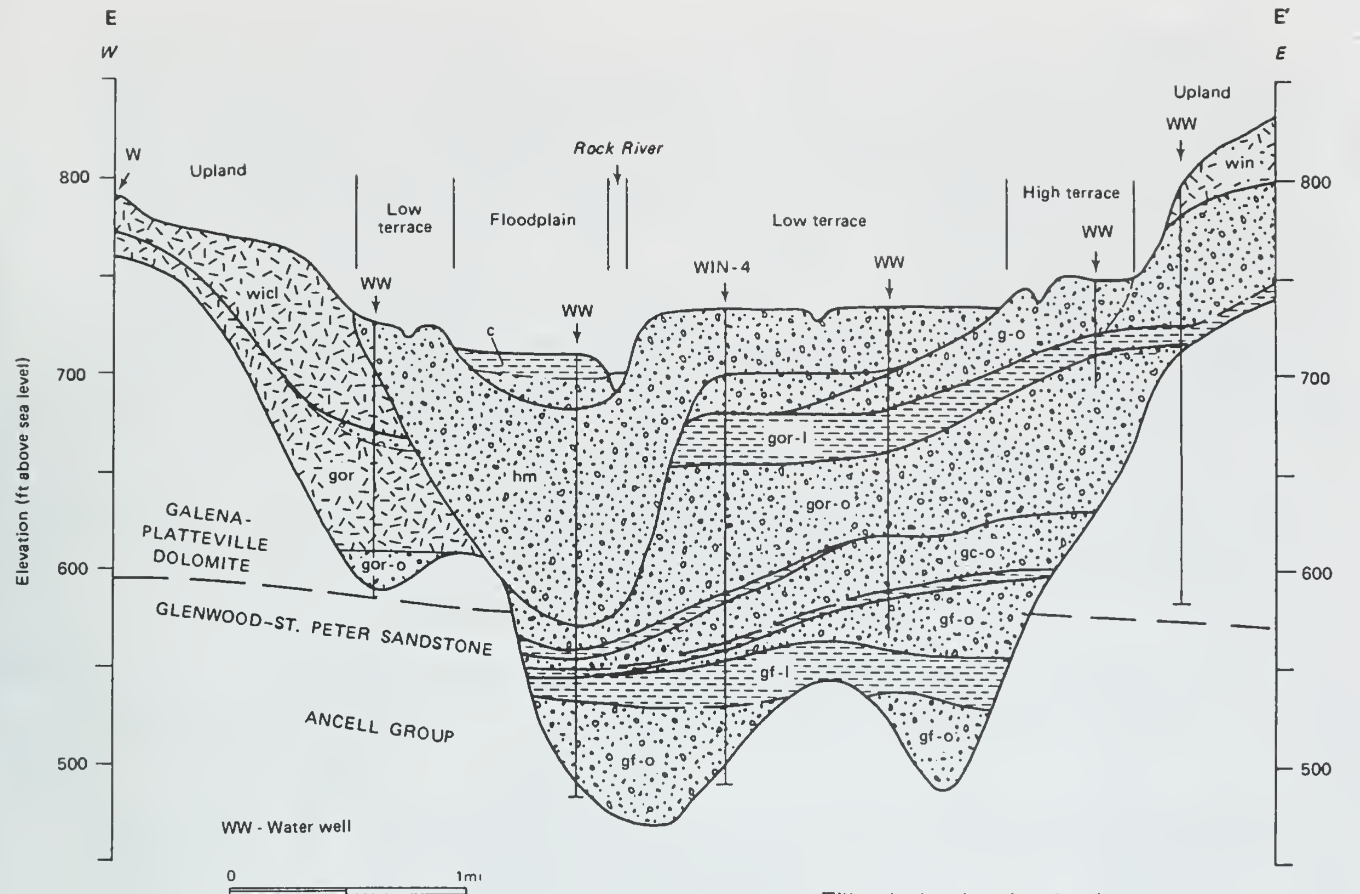

Figure 14 West–east cross section across the Rock River valley near Loves Park (modified from Berg, Kempton, and Stecyk 1984).

Till and other deposits related to:

Stack symbol	Units	
wic	Capron	Winnebago
wicl	Clinton	Winnebago
wia	Argyle	Winnebago
win	Nimtz	Winnebago
g-o	Uppermost Glasford Formation outwash	Glasford
gb	Belvidere	Glasford
ge	Esmond	Glasford
gor	Oregon	Glasford
gc	Creston	Glasford
gf	Fairdale	Glasford
gh	Herbert	Glasford
go	Ogle	Glasford
gk	Kellerville	Glasford
-l	Lacustrine	
-o	Outwash	
-a	Ablation	
c	Cahokia alluvium	
hm	Henry Formation, Mackinaw member sand and gravel	
ec	Equality Carmi; Lake silts	

Till

Outwash sand and gravel

Lacustrine sands, silt and clay

Organic materials or buried soil

Specific borings indicated

Figure 15 Topography of the bedrock surface of Winnebago County (modified from Berg, Kempton, and Stecyk 1984).

To give some ideas of the amount of outwash material that was originally deposited within the Rock River valley, the elevation of the upper terraces of the Rock River valley is about 750–760 feet above sea level, and the current elevation of Rock River is 710 feet above sea level. Rock River is located 2½ miles west of this location. Imagine a deposit of sand and gravel 50 feet thick, 2½ miles wide, and extending for tens of miles both upstream and downstream. The Rock River has been very busy over the last 13,000+ years, reworking, removing, and cutting down to its present level.

STOP 3 Rockford Sand and Gravel Company, North Shore Plant (SE, NE, Sec. 8, and SW, NW, Sec. 9, T45N, R2E, 3rd P.M., South Beloit 7.5-Minute Quadrangle) We will examine the dredging operation and the Rock River valley outwash deposits of the Mackinaw Member of the Henry Formation of Wisconsinan age.

The Rock Bedrock Valley (figs. 13, 14, and 15), which is approximately 1½ to 2½ miles wide and 200 to 300 feet below the bedrock uplands, enters Winnebago County from Rock County, Wisconsin, approximately 4 miles west of the Boone–Winnebago County line, and trends southward into Ogle County, leaving Winnebago County in Section 35, T43N, R1E.

Along the deepest part of the Rock Bedrock Valley in Winnebago Co., the bedrock surface elevation ranges from about 500 feet in the north to 450 feet in the south; the associated drift thickness varies between 200 and 300 feet.

The Rock Bedrock Valley is filled primarily with silt and sand and gravel deposits. The modern Rock River generally flows in the same valley as the ancient Rock River, with two notable exceptions. The present river flows along the west edge of the bedrock valley at Rockford, across an area of high bedrock. In this area, the axis of the bedrock valley lies just to the east beneath the till that forms the upland. At the southern edge of Winnebago County, the present river turns southwestward away from the ancient bedrock valley. The elevation of the modern surface of the valley above the Rock Bedrock Valley ranges from 780 feet in the north to 680 feet in the south.

The ancient Pecatonica–Sugar Bedrock Valley, a major east-trending tributary of the Rock Bedrock Valley, is approximately 1 to 2 miles wide and 150 to 250 feet deep, and is filled by thick deposits of silt and sand and gravel. The Pecatonica Bedrock Valley enters Winnebago County from Stephenson County at Section 19, T27N, R10E, and trends east-northeast. The Sugar Bedrock Valley enters Winnebago County from Rock County, Wisconsin, at Section 6, T29N, R11E. The Pecatonica–Sugar Bedrock Valley then trends east and enters the Rock Bedrock Valley at Section 18, T46N, R2E. The modern Sugar and Pecatonica Rivers flow over the ancestral Pecatonica and Sugar Bedrock Valleys. The elevation of the bedrock surface along the ancient Pecatonica and Sugar Bedrock Valleys ranges from less than 600 feet in upstream positions to 500 feet, where the Pecatonica Bedrock Valley joins the Rock Bedrock Valley. The drift also thickens to the east, ranging from 150 feet thick in up-valley positions, where the bedrock valley floor is higher to more than 250 feet thick at the joining of the Pecatonica and Rock Bedrock Valleys, where the bedrock valley floor is 100 feet lower. Backwater sedimentation filled the ancient valleys and constructed a relatively flat modern topography.

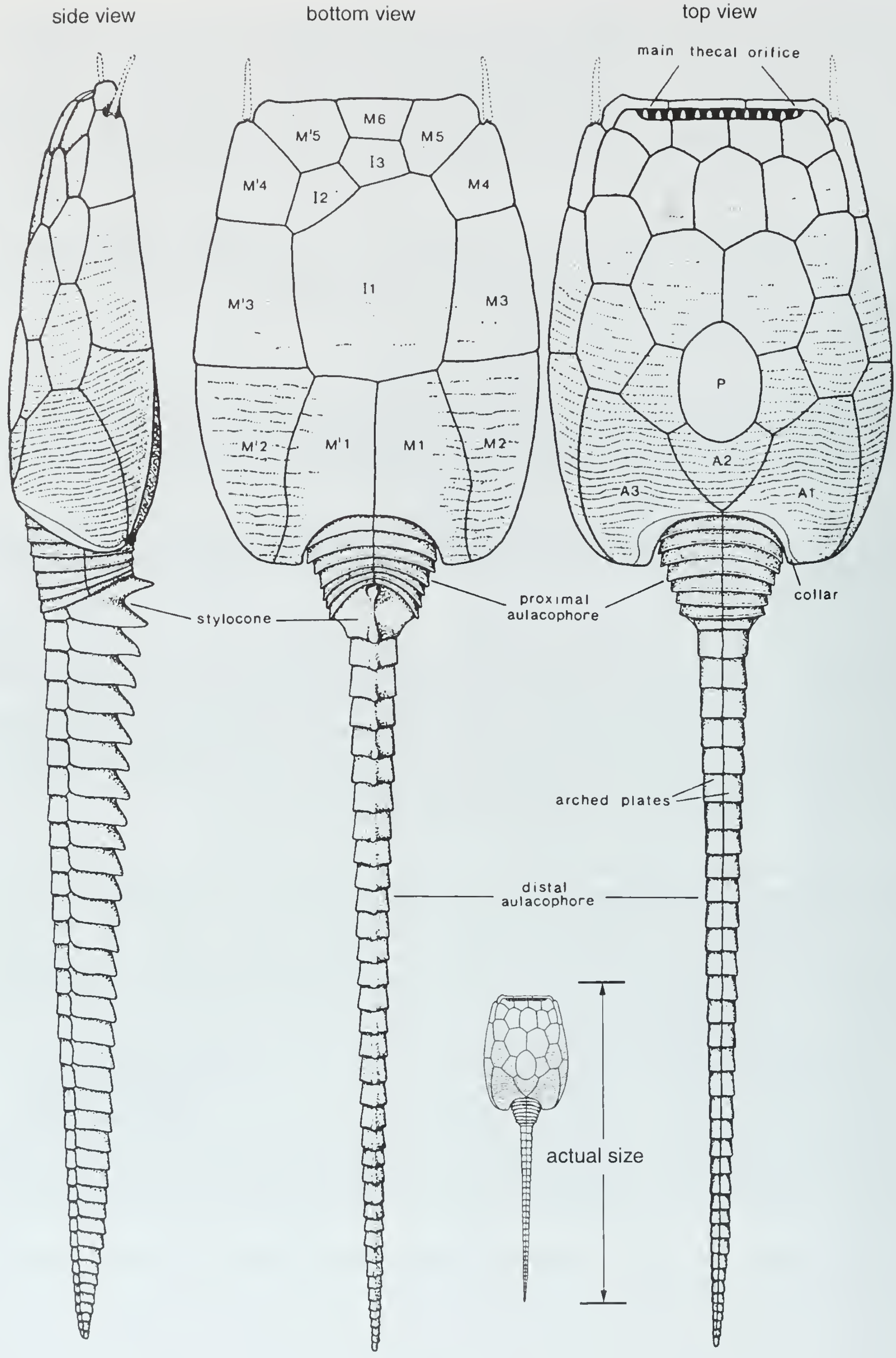

Figure 16 *Ateleocyctites guttenbergensis*, a rare echinoderm from the Ordovician-age Guttenberg Formation of the Galena Group.

STOP 4: Lunch Atwood Homestead Forest Preserve (NW, NW, SE, Sec.7, T45N, R2E, 3rd P.M., South Beloit 7.5-Minute Quadrangle)

STOP 5 Austin Quarry (SE, NW, SE, Sec. 35, T29N, R11E, 4th P.M., Shirland 7.5-Minute Quadrangle, Winnebago County, Illinois). The quarry is on east side of Boswell Road, 1½ miles north of Shirland.

This quarry exposes the upper part of the Platteville Group and a few basal feet of the Galena Group, which contain the richly fossiliferous Guttenberg Formation (figs. 7a and 7b). Crushed rock has been quarried from this location for over 30 years for use mainly in building and maintaining local roads. About 10 years ago, the dolomite was drilled and blasted into boulder-sized pieces, much of which remains at the south end of the quarry. This blasted material is great for collecting because ice, rain, snow, and the heat of the sun have caused the dolomite to weather, which has exhumed abundant fossils of trilobites, crinoids, brachiopods, bryozoans, snails, clams, cephalopods, and corals (figs. 6a and 6b).

Two years ago, about a dozen nearly complete specimens of an extinct group of echinoderms called "carpoids" were discovered in the Guttenburg Formation in the large blocks at the south end of this quarry. These are very rare fossils, and the discovery of this many specimens at one locality is most unusual. Figure 16 shows the top, bottom, and side views of these unusual echinoderms. Their scientific name is *Ateleocyctites guttenbergensis,* and they are only known from the Guttenberg Formation in the Mississippi Valley region.

OUTCROP DESCRIPTION

Austin Quarry
Winnebago County, Shirland Quadrangle
SE, NW, SE, Sec. 35, T29N, R11E

Galena Group

Dunleith Formation (~ 8′; covered at top)

Thickness	
~ 8′	**Dolomite** – buff to light greenish gray, medium grained, greenish gray shale partings, fossiliferous (bryozoans, brachiopods, crinoids, trilobites).

Guttenberg Formation

2′	**Dolomite** – light gray to buff, medium grained, distinct reddish brown organic-rich shale partings, very fossiliferous (bryozoans, brachiopods, crinoids, trilobites).

Platteville Group

Quimbys Mill Formation (7′)

6′	**Dolomite** – buff, fine grained, dense, fossiliferous; 1″ to 3″ beds.
1′	**Dolomite** – as above, but more argillaceous; contains nodular beds; molluscan fossils common; small *Chondrites*.

Nachusa Formation (14′)

Everett Member

6′	**Dolomite** – pure, buff, medium grained, vuggy; rough weathered face; 2″ to 12″ beds; silicified *Foerstephyllum* and *Streptelasma*; chert nodules at top and 2′ above base.

Elm Member

2′	**Dolomite** – moderately argillaceous, fine grained, dense, laminated; 6″ to 12″ beds; smooth weathered face; silicified fossils.

Eldena Member

6′	**Dolomite** – pure, buff, medium grained, vuggy; rough weathered face; 4″ to 6″ beds.

Grand Detour Formation

Forreston Member (8′)

8′	**Dolomite** – argillaceous, gray to buff, fine grained; 1″ to 4″ wavy beds; dark reddish brown shale partings; smooth weathered face; diverse and abundant fauna.

STOP 6 Colored Sands Forest Preserve – windblown dune (St. Peter Sandstone) along the Sugar River.

STOP 6 Colored Sands Forest Preserve (NE, SE, Sec. 29, T29N, R11E, 4th P.M., Shirland 7.5-Minute Quadrangle)

Follow the trail located left of the visitors center to the overlook of the Sugar River. We will examine an exposure of windblown St. Peter Sandstone, which forms a large dune in this area, and discuss the history and relationship between the Sugar, the Pecatonica, and the Rock Rivers.

The Sugar River enters the Pecatonica River south of the community of Shirland (see route maps). This was at mile 29.5 in the Guide to the Route. From where the rivers come together, they flow eastward 7 miles to empty into the Rock River at Rockton. The Pecatonica River has its source far to the west in southwestern Wisconsin. The Sugar River heads more directly to the north near Madison, Wisconsin.

Starting approximately 25,000 years ago, long after the Illinoian Glacier had melted away and when the edge of the Wisconsinan Glacier lay 20 miles to the north, a torrent from the melting ice was pouring down the Rock River valley. A lesser torrent was racing down the Sugar River valley. But the Pecatonica River, with its headwaters far to the west, had no contact with the melting Wisconsinan Ice.

The glacial torrents carried great quantities of sand and gravel washed out from the melting ice, and dropped this load of sediment downstream through the Rockton–Rockford country. Consequently,

these streams built up their beds to higher and higher elevations. But the Pecatonica River went on receiving only a normal amount of water and sediment, so that it filled its bed much more slowly. As a result, the sediment piled across the mouth of the Pecatonica by the Rock and Sugar Rivers acted as a dam, which backed up the waters of the former and converted much of its valley to a long, narrow lake.

In time the mud carried by the Pecatonica filled up the lake. Today the river winds and meanders, a stream lost in its mud flats. Among Illinois rivers, the Pecatonica is most noted for its winding course and almost annual flooding. For this latter reason, few houses are built on the rich floodplain of the river.

While great quantities of gravel were being washed down the Rock River from the melting ice of the Wisconsinan Glacier, the Sugar River was carrying sand. Consequently, the floodplain of the Sugar River was a vast sand flat where the prevailing westerly winds picked up the sand and deposited it in dunes over the uplands on the east side of the Sugar River valley.

This sand is reworked St. Peter Sandstone, which is an unusually pure, uniformly fine-grained, and well-sorted quartz sandstone. The origin of the name Sugar River can easily be understood once one investigates the deposits along the Sugar River valley.

STOP 7 Rockford Sand and Gravel Company, Farm Quarry (SE, Sec. 36, T28N, R10E, 4th P.M., Durand 7.5-Minute Quadrangle, Winnebago County). The quarry is on the north side of State Route 70/Trask Bridge Road, 4½ miles southeast of Durand.

Like the Shirland North Section (Stop 5), this quarry exposes the upper part of the Platteville Group and basal part of the overlying Galena Group including the Guttenberg Formation (figs. 7a and 7b). Crushed rock has been quarried from this location for over 40 years for use mainly in building and maintaining local roads. Most recently, crushed rock was removed from the quarry to resurface nearby parts of State Route 70.

This quarry has yielded some outstanding fossils over the years. Of particular note are the diverse and well-preserved trilobites and echinoderms. The six-foot-long fossil cephalopod, long known as the “Rockford Sea Monster,” on exhibit at the Burpee Museum of Natural History, in downtown Rockford, was discovered in this quarry about 40 years ago. Also on exhibit at the museum are some of the spectacular trilobites and crinoids that have been found here. Many of the Platteville fossils shown in figure 6a, including the *Ceraurus* trilobite, were collected from this quarry.

Near the top of the Mifflin Formation, exposed in the lower quarry floor, are some lithistid sponges (*Anthaspidella* and *Zittelella*). They are present at other localities in northern Illinois but only at this stratigraphic level. The sponges are not obvious, so you will have to be patient and look carefully.

OUTCROP DESCRIPTION

Durand Southeast Section
Winnebago County, Pecatonica Quadrangle
SW, SE, SE, Sec. 36, T28N, R10E

Quarry on north side of State Route 70
4½ miles southeast of Durand, Winnebago, Co., IL.

Galena Group

Thickness	
	Dunleith Formation (~ 6′; covered at top)
~6′	**Dolomite** – buff to light greenish gray, medium grained, greenish gray shale partings, fossiliferous (bryozoans, brachiopods, crinoids, trilobites).
	Guttenberg Formation
2′	**Dolomite** – light gray to buff, medium grained, distinct reddish brown organic-rich shale partings, very fossiliferous (bryozoans, brachiopods, crinoids, trilobites).
	Platteville Group
	Quimbys Mill Formation (7′ 6″)
6½′	**Dolomite** – buff, fine grained, dense, fossiliferous; 1″ to 3″ beds.
1′	**Dolomite** – as above but more argillaceous; 1″ nodular beds; molluscan fossils common; small *Chondrites*.
	Nachusa Formation (14′)
	Everett Member
5′ 8″	**Dolomite** – pure, buff, medium grained, vuggy; rough weathered face; 2″ to 12″ beds; silicified *Foerstephyllum* and *Streptelasma*; chert nodules at top and 2′ above base.
	Elm Member
2′	**Dolomite** – moderately argillaceous, fine grained, dense, laminated; 6″ to 12″ beds; smooth weathered face; silicified fossils.
	Eldena Member
6′ 4″	**Dolomite** – pure, buff, medium grained, vuggy; rough weathered face; 4″ to 6″ beds; silicified *Öpikina* and *Streptelasma*; molluscan fossils abundant 3′ above base;Palaeo phycus.
	Grand Detour Formation (32′ 3″)
	Forreston Member (16′ 9″)
12½′	**Dolomite** – argillaceous, gray to buff, fine grained; 1″ to 4″ wavy beds; dark brown shale partings; smooth weathered face; diverse and abundant fauna.
2′ 5″	**Dolomite** – as above, but less abundant shelly fauna and numerous, small, light colored, horizontal burrows; 1″ to 6″ beds.

1′ 10″ **Dolomite** – as above, but without burrows; prominent shaley reentrant at top; 1″ calcarenite 6″ above base.

Stillman Member (15½′)

6′ 8″ **Dolomite** – relatively pure, buff, vuggy, fossiliferous; rough weathered face; 6″ to 8″ beds; lumpy, irregular bedding surfaces; *Vanuxemia* common 3 above base.

1′ **Dolomite** – as above, but cherty; thin, reddish brown shaley partings.

4′ 4″ **Dolomite** – pure, buff; small chert nodules in upper 1′; 4″ to 6″ graded calcarenite 2′ above base.

2′ **Dolomite** – as above but without chert; two calcarenite beds 1″ to 4″ thick.

1½′ **Dolomite** – argillaceous, buff; 1″ to 2″ wavy, lenticular beds; abundant and diverse fauna; lithistid sponges (*Anthaspidella, Zittelella*); two thin calcarenite beds in the lower part.

Mifflin Formation

6′ **Dolomite** – argillaceous, gray to buff, fine grained, fossiliferous; 1″ to 3″ wavy lenticular beds; green shale partings.

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GLOSSARY

The following definitions are adapted in total or in part from several sources; the principal source is R.L. Bates and J.A Jackson, eds.,Glossary of Geology, 3rd ed.: American Geological Institute, Alexandria, VA, 1987, 788 p.

Ablation - Separation and removal of rock material and formation of deposits, especially by wind action or the washing away of loose and soluble materials.

Age - An interval of geologic time; a division of an epoch.

Aggrading stream - One that is actively depositing sediment in its channel or floodplain because it is being supplied with more load than it can transport.

Alluviated valley - One that has been at least partially filled with sand, silt, and mud by flowing water.

Alluvium - A general term for clay, silt, sand, gravel, or similar unconsolidated sorted or semisorted sediment deposited during comparatively recent time by a stream or other body of running water.

Anticline - A convex-upward rock fold in which strata have been bent into an arch; the strata on either side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.

Aquifer - A geologic formation that is water-bearing and which transmits water from one point to another.

Argillaceous - Said of rock or sediment that contains, or is composed of, clay-sized particles or clay minerals.

Arenite - A relatively clean quartz sandstone that is well sorted and contains less than 10% argillaceous material.

Base level - Lower limit of erosion of the land's surface by running water. Controlled locally and temporarily by the water level of stream mouths emptying into lakes, or more generally and semipermanently by the level of the ocean (mean sea level).

Basement complex - The suite of mostly crystalline igneous and/or metamorphic rocks that generally underlies the sedimentary rock sequence.

Basin - A topographic or structural low area that generally receives thicker deposits of sediments than adjacent areas; the low areas tend to sink more readily, partly because of the weight of the thicker sediments; the term also denotes an area of relatively deep water adjacent to shallow-water shelf areas.

Bed - A naturally occurring layer of earth material of relatively greater horizontal than vertical extent that is characterized by physical properties different from those of overlying and underlying materials. It also is the ground upon which any body of water rests or has rested, or the land covered by the waters of a stream, lake, or ocean; the bottom of a stream channel.

Bedrock - The solid rock (sedimentary, igneous, or metamorphic) that underlies the unconsolidated (non-indurated) surface materials (for example, soil, sand, gravel, glacial till, etc.).

Bedrock valley - A drainageway eroded into the solid bedrock beneath the surface materials. It may be completely filled with unconsolidated (non-indurated) materials and hidden from view.

Braided stream - A low-gradient, low-volume stream flowing through an intricate network of interlacing shallow channels that repeatedly merge and divide, and are separated from each other by branch islands or channel bars. Such a stream may be incapable of carrying all of its load. Most streams that receive more sediment load than they can carry become braided.

Calcarenite - Describes a limestone composed of more or less worn fragments of shells or pieces of older limestone. The particles are generally sand-sized.

Calcareous - Said of a rock containing some calcium carbonate ($CaCO_3$), but composed mostly of something else; (synonym: limey).

Calcining - The heating of calcite or limestone to its temperature of dissociation so that it loses its carbon dioxide; also applied to the heating of gypsum to drive off its water of crystallization to make plaster of paris.

Calcite - A common rock-forming mineral consisting of $CaCO_3$; it may be white, colorless, or pale shades of gray, yellow, and blue; it has perfect rhombohedral cleavage, appears vitreous, and has a hardness of 3 on the Mohs scale; it effervesces (fizzes) readily in cold dilute hydrochloric acid. It is the principal constituent of limestone.

Chert - Silicon dioxide (SiO_2); a compact, massive rock composed of minute particles of quartz and/or chalcedony; it is similar to flint, but lighter in color.

Clastic - Said of rocks composed of particles of other rocks or minerals, including broken organic hard parts as well as rock substances of any sort, transported and deposited by wind, water, ice or gravity.

Closure - The difference in altitude between the crest of a dome or anticline and the lowest structural or elevation contour that completely surrounds it.

Columnar section - A graphic representation, in the form of one or more vertical column(s), of the vertical succession and stratigraphic relations of rock units in a region.

Conformable - Said of strata deposited one upon another without interruption in accumulation of sediment; beds parallel.

Delta - A low, nearly flat, alluvial land form deposited at or near the mouth of a river where it enters a body of standing water; commonly a triangular or fan-shaped plain extending beyond the general trend of a coastline.

Detritus - Loose rock and mineral material produced by mechanical disintegration and removed from its place of origin by wind, water, gravity, or ice; also, fine particles of organic matter, such as plant debris.

Disconformity - An *unconformity* marked by a distinct erosion-produced irregular, uneven surface of appreciable relief between parallel strata below and above the break; sometimes represents a considerable time interval of nondeposition.

Dolomite - A mineral, calcium-magnesium carbonate ($Ca,Mg[CO_3]_2$); also the name applied to sedimentary rocks composed largely of the mineral. It is white, colorless, or tinged yellow, brown, pink, or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; effervesces feebly in cold dilute hydrochloric acid.

Drift - All rock material transported by a glacier and deposited either directly by the ice or reworked and deposited by meltwater streams and/or the wind.

Driftless Area - A 10,000-square-mile area in northeastern Iowa, southwestern Wisconsin, and northwestern Illinois where the absence of glacial drift suggests that the area may not have been glaciated.

End moraine - A ridge or series of ridges formed by accumulations of drift built up along the outer margin of an actively flowing glacier at any given time; a moraine that has been deposited at the lower or outer end of a glacier.

Epoch - An interval of geologic time; a division of a period. (Example: Pleistocene Epoch).

Era - The unit of geologic time that is next in magnitude beneath an eon; it consists of two or more periods. (Example: Paleozoic Era).

Escarpment - A long, more or less continuous cliff or steep slope facing in one general direction; it generally marks the outcrop of a resistant layer of rocks, or the exposed plane of a fault that has moved recently.

Fault - A fracture surface or zone of fractures in Earth materials along which there has been vertical and/or horizontal displacement or movement of the strata on opposite sides relative to one another.

Flaggy - Said of rock that tends to split into layers of suitable thickness for use as flagstone.

Flood plain - The surface or strip of relatively smooth land adjacent to a stream channel produced by the stream's erosion and deposition actions; the area covered with water when the stream overflows its banks at times of high water; it is built of alluvium carried by the stream during floods and deposited in the sluggish water beyond the influence of the swiftest current.

Fluvial - Of or pertaining to a river or rivers.

Formation - The basic rock unit, one distinctive enough to be readily recognizable in the field and widespread and thick enough to be plotted on a map. It describes the strata, such as limestone, sandstone, shale, or combinations of these and other rock types. Formations have formal names, such as Joliet Formation or St. Louis Limestone (Formation), generally derived from the geographic localities where the unit was first recognized and described.

Fossil - Any remains or traces of a once-living plant or animal preserved in rocks (arbitrarily excludes Recent remains); any evidence of ancient life. Also used to refer to any object that existed in the geologic past and for which evidence remains (for example, a fossil waterfall)

Friable - Said of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder, such as a soft and poorly cemmented sandstone.

Geology - The study of the planet Earth that is concerned with its origin, composition, and form, its evolution and history, and the processes that acted (and act) upon it to control its historic and present forms.

Geophysics - Study of the Earth with quantitative physical methods. Application of the principles of physics to the study of the earth, especially its interior.

Glaciation - A collective term for the geologic processes of glacial activity, including erosion and deposition, and the resulting effects of such action on the Earth's surface.

Glacier - A large, slow-moving mass of ice formed on land by the compaction and recrystallization of snow.

Gradient - A part of a surface feature of the Earth that slopes upward or downward; the angle of slope, as of a stream channel or of a land surface, generally expressed by a ratio of height versus distance, a percentage or an angular measure from the horizontal.

Igneous - Said of a rock or mineral that solidified from molten or partly molten material (that is, from magma).

Indurated - Said of compact rock or soil hardened by the action of pressure, cementation and, especially, heat.

Joint - A fracture or crack in rocks along which there has been no movement of the opposing sides (see also *Fault*).

Karst - Collective term for the land forms and subterranean features found in areas with relatively thin soils underlain by limestone or other soluble rocks; characterized by many sinkholes separated by steep ridges or irregular hills. Tunnels and caves formed by dissolution of the bedrock by groundwater honeycomb the subsurface. Named for the region around Karst in the Dinaric Alps of Croatia where such features were first recognized and described.

Lacustrine - Produced by or belonging to a lake.

Laurasia - A protocontinent of the Northern Hemisphere, corresponding to Gondwana in the Southern Hemisphere, from which the present continents of the Northern Hemisphere have been derived by separation and continental displacement. The supercontinent from which both were derived is Pangea. Laurasia included most of North America, Greenland, and most of Eurasia, excluding India. The main zone of separation was in the North Atlantic, with a branch in Hudson Bay; geologic features on opposite sides of these zones are very similar.

Lava - Molten, fluid rock that is extruded onto the surface of the Earth through a volcano or fissure. Also the solid rock formed when the lava has cooled.

Limestone - A sedimentary rock consisting primarily of calcium carbonate (the mineral, calcite). Limestone is generally formed by accumulation, mostly in place or with only short transport, of the shells of marine animals, but it may also form by direct chemical precipitation from solution in hot springs or caves and, in some instances, in the ocean.

Lithify - To change to stone, or to petrify; especially to consolidate from a loose sediment to a solid rock.

Lithology - The description of rocks on the basis of their color, structure, mineral composition, and grain size; the physical character of a rock.

Local relief - The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or in a limited area.

Loess - A homogeneous, unstratified accumulation of silt-sized material deposited by the wind.

Magma - Naturally occurring molten rock material generated within Earth and capable of intrusion into surrounding rocks or extrusion onto the Earth's surface. When extruded on the surface it is called lava. The material from which igneous rocks form through cooling, crystallization, and related processes.

Meander - One of a series of somewhat regular, sharp, sinuous curves, bends, loops, or turns produced by a stream, particularly in its lower course where it swings from side to side across its valley bottom.

Meander scars - Crescent-shaped swales and gentle ridges along a river's flood plain that mark the positions of abandoned parts of a meandering river's channel. They are generally filled in with sediments and vegetation and are most easily seen in aerial photographs.

Metamorphic rock - Any rock derived from pre-existing rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in Earth's crust (for example, gneisses, schists, marbles, quartzites, etc.)

Mineral - A naturally formed chemical element or compound having a definite chemical composition, an ordered internal arrangement of its atoms, and characteristic crystal form and physical properties.

Monolith - (a) A piece of unfractured bedrock, generally more than a few meters across. (b) A large upstanding mass of rock.

Moraine - A mound, ridge, or other distinct accumulation of glacial drift, predominantly till, deposited in a variety of topographic land forms that are independent of control by the surface on which the drift lies (see also *End Moraine*).

Morphology - The scientific study of form, and of the structures and development that influence form; term used in most sciences.

Natural gamma log - One of several kinds of measurements of rock characteristics taken by lowering instruments into cased or uncased, air- or water-filled boreholes. Elevated natural gamma radiation levels in a rock generally indicate the presence of clay minerals.

Nickpoint - A place with an abrupt inflection in a stream profile, generally formed by the presence of a rock layer resistant to erosion; also, a sharp angle cut by currents at base of a cliff.

Nonconformity - An unconformity resulting from deposition of sedimentary strata on massive crystalline rock.

Outwash - Stratified glacially derived sediment (clay, silt, sand, gravel) deposited by meltwater streams in channels, deltas, outwash plains, on flood plains, and in glacial lakes.

Outwash plain - The surface of a broad body of outwash formed in front of a glacier.

Oxbow lake - A crescent-shaped lake in an abandoned bend of a river channel. A precursor of a meander scar.

Pangea - The supercontinent that existed from 300 to 200 million years ago. It combined most of the continental crust of the Earth, from which the present continents were derived by fragmentation and movement away from each other by means of plate tectonics. During an intermediate stage of the fragmentation, between the existence of Pangea and that of the present widely separated continents, Pangea was split into two large fragments, *Laurasia* on the north and *Gondwana* in the southern hemisphere.

Ped - Any naturally formed unit of soil structure (for example, granule, block, crumb, or aggregate).

Peneplain - A land surface of regional scope worn down by erosion to a nearly flat or broadly undulating plain.

Period - An interval of geologic time; a division of an era (for example, Cambrian, Jurassic, Tertiary).

Physiography - The study and classification of the surface features of Earth on the basis of similarities in geologic strucure and the history of geologic changes.

Physiographic province (or division) - (a) A region, all parts of which are similar in geologic structure and climate and which has consequently had a unified geologic history. (b) Aa region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Point bar - A low arcuate ridge of sand and gravel developed on the inside of a stream meander by accumulation of sediment as the stream channel migrates toward the outer bank.

Radioactivity logs - Any of several types of geophysical measurements taken in bore holes using either the natural radioactivity in the rocks, or the effects of radiation on the rocks to determine the lithology or other characteristics of the rocks in the walls of the borehole. (Examples: natural gamma radiation log; neutron density log).

Relief - (a) A term used loosely for the actual physical shape, configuration, or general uneveness of a part of Earth's surface, considered with reference to variations of height and slope or to irregularities of the land surface; the elevations or differences in elevation, considered collectively, of a land surface (frequently confused with topography). (b) The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given region; "high relief" has great variation; "low relief" has little variation.

Rift - A long narrow trough, generally on a continent, bounded by normal faults, a graben with regional extent. Formed in places where the forces of plate tectonics are beginning to split a continent. (Example: East African Rift Valley).

Sediment - Solid fragmental matter, either inorganic or organic, that originates from weathering of rocks and is transported and deposited by air, water, or ice, or that is accumulated by other natural agents, such as chemical precipitation from solution or secretion from organisms. When deposited, it generally forms layers of loose, unconsolidated material (for example, sand, gravel, silt, mud, till, loess, alluvium).

Sedimentary rock - A rock resulting from the consolidation of loose sediment that has accumulated in layers (for example, sandstone, siltstone, mudstone, limestone).

Shoaling - Said of an ocean or lake bottom that becomes progressively shallower as a shoreline is approached. The shoaling of the ocean bottom causes waves to rise in height and break as they approach the shore.

Sinkhole - Any closed depression in the land surface formed as a result of the collapse of the underlying soil or bedrock into a cavity. Sinkholes are common in areas where bedrock is near the surface and susceptible to dissolution by infiltrating surface water. Sinkhole is synonymous with "doline," a term used extensively in Europe. The essential component of a hydrologically active sinkhole is a drain that allows any water that flows into the sinkhole to flow out the bottom into an underground conduit.

Slip-off slope - Long, low, gentle slope on the inside of a stream meander. The slope on which the sand that forms point bars is deposited.

Stage, substage - Geologic time-rock units; the strata formed during an age or subage, respectively. Generally applied to glacial episodes (for example, to the Woodfordian Substage of the Wisconsinan Stage.

Stratigraphy - The study, definition, and description of major and minor natural divisions of rocks, particularly the study of their form, arrangement, geographic distribution, chronologic succession, naming or classification, correlation, and mutual relationships of rock strata.

Stratigraphic unit - A stratum or body of strata recognized as a unit in the classification of the rocks of Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

Stratum - A tabular or sheet-like mass, or a single, distinct layer of material of any thickness, separable from other layers above and below by a discrete change in character of the material or by a sharp physical break, or by both. The term is generally applied to sedimentary rocks, but could be applied to any tabular body of rock. (See also *Bed*)

Subage - A small interval of geologic time; a division of an age.

Syncline - A convex-downward fold in which the strata have been bent to form a trough; the strat on either side of the core of the trough are inclined in opposite directions toward the axis of the fold; the core area of the fold contains the youngest rocks. (See also *Anticline*).

System - A fundamental geologic time-rock unit of worldwide significance; the strata of a system are those deposited during a period of geologic time (for example, rocks formed during the Pennsylvanian Period are included in the Pennsylvanian System).

Tectonic - Pertaining to the global forces that cause folding and faulting of the Earth's crust. Also used to classify or describe features or structures formed by the action of those forces.

Tectonics - The branch of geology dealing with the broad architecture of the upper (outer) part of Earth; that is, the major structural or deformational features, their origins, historical evolution, and relations to each other. It is similar to structural geology, but generally deals with larger features such as whole mountain ranges, or continents.

Temperature-resistance log - A borehole log, run only in water-filled boreholes, that measures the water temperature and the quality of groundwater in the well.

Terrace - An abandoned floodplain formed when a stream flowed at a level above the level of its present channel and floodplain.

Till - Unlithified, nonsorted, unstratified drift deposited by and underneath a glacier and consisting of a heterogenous mixture of different sizes and kinds of rock fragments.

Till plain - The undulating surface of low relief in an area underlain by ground moraine.

Topography - The natural or physical surface features of a region, considered collectively as to form; the features revealed by the contour lines of a map.

Unconformable - Said of strata that do not succeed the underlying rocks in immediate order of age or in parallel position. A general term applied to any strata deposited directly upon older rocks after an interruption in sedimentation, with or without any deformation and/or erosion of the older rocks.

Unconformity - A surface of erosion or nondeposition that separates younger strata from older strata; most unconformities indicate intervals of time when former areas of the sea bottom were temporarily raised above sea level.

Valley trains - The accumulations of outwash deposited by rivers in their valleys downstream from a glacier.

Water table - The point in a well or opening in the Earth where groundwater begins. It generally marks the top of the zone where the pores in the surrounding rocks are fully saturated with water.

Weathering - The group of processes, both chemical and physical, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

Geobit 1

EXOTIC ROCKS or Erratics Are Erratic

A piece of Canada sitting in central Illinois (photo by D. Reinertsen).

Here and there in Illinois are boulders lying alone or with companions in the corner of a field or someone's yard, on a courthouse lawn or a schoolyard. Many of them—colorful and glittering granites, banded gneisses, and other intricately veined and streaked igneous and metamorphic rocks—seem out of place in the stoneless, grassy knolls and prairies of our state. Their "erratic" occurrence is the reason for their interesting name.

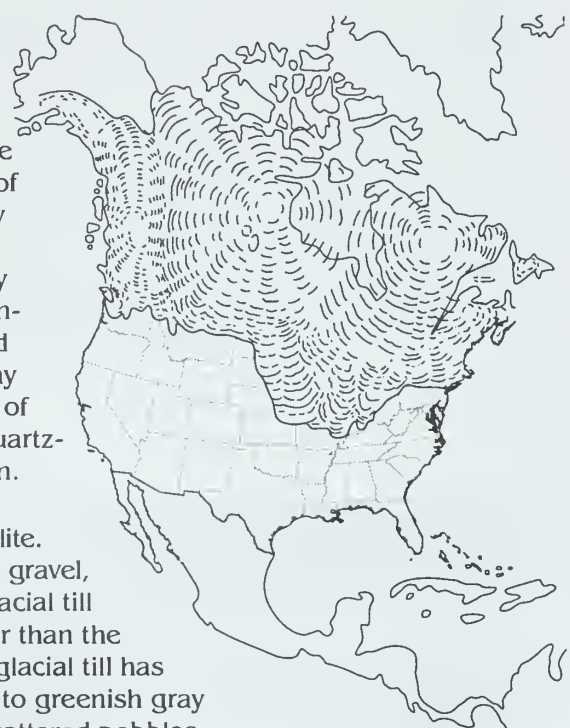
Where did erratics come from?

These exotic rocks came from Canada and the states north of us. The continental glaciers of the Great Ice Age scoured and scraped the land surface as they advanced, pushing up chunks of bedrock and grinding them against each other or along the ground surface as the rock-laden ice sheets pushed southward.

Sometimes you can tell where the erratic originally came from by determining the kind of rock it is. A large boulder of granite, gneiss, or other igneous or metamorphic rock may have come from Canada.

Some erratics containing flecks of copper were probably transported here from the "Copper Range" of the upper peninsula of Michigan. Large pieces of copper have been found in glacial deposits of central and northern Illinois. Light gray to white quartzite boulders with beautiful, rounded pebbles of red jasper came from Ontario, Canada. Purplish pieces of quartzite, some of them banded, probably originated in Wisconsin.

Most interesting are the few large boulders of Canadian tillite. Glacial till is an unsorted and unlayered mixture of clay, sand, gravel, and boulders that vary widely in size and shape. Tillite is glacial till that was deposited by a glacier many millions of years older than the ones that invaded our state during the Great Ice Age. This glacial till has been around so long that it has been hardened into a gray to greenish gray rock containing a mixture of grains of different sizes and scattered pebbles of various types and sizes.



Glaciers spread southward into the Midwest from two centers of ice accumulation in western and eastern Canada

How did erratics get here?

Many boulders were probably dropped directly from the melting front of the glacier. Others may have been rafted to their present resting places by icebergs in ancient lakes or on flood-waters of some long-vanished stream as it poured from a glacier. Still others, buried in the glacial deposits, could have worked their way up to the land surface as the surrounding loose soil repeatedly froze and thawed. When the freezing ground expands, pieces of rock tend to be pushed upward, where they are more easily reached by the farmer's plow and also more likely to be exposed by erosion.

> *Keep an eye out for erratics. You may find some of these glacial strangers in your neighborhood.*

Many erratics are of notable size and beauty. Some are used as monuments in courthouse squares and parks, or along highways. Many are marked with metal plaques to indicate an interesting historical spot or event.

Contributed by M.M. Killey

While on a drive through central Illinois, you may catch a glimpse of an erratic (photo by J. Dexter).

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PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

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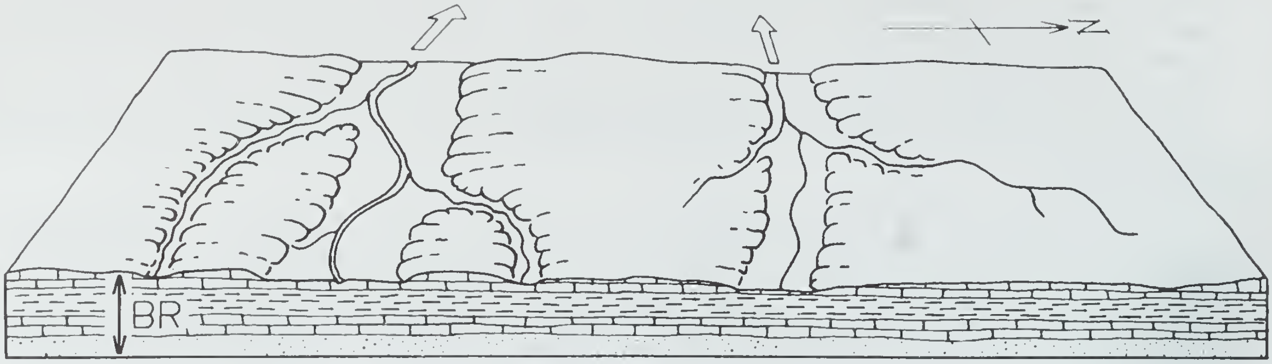
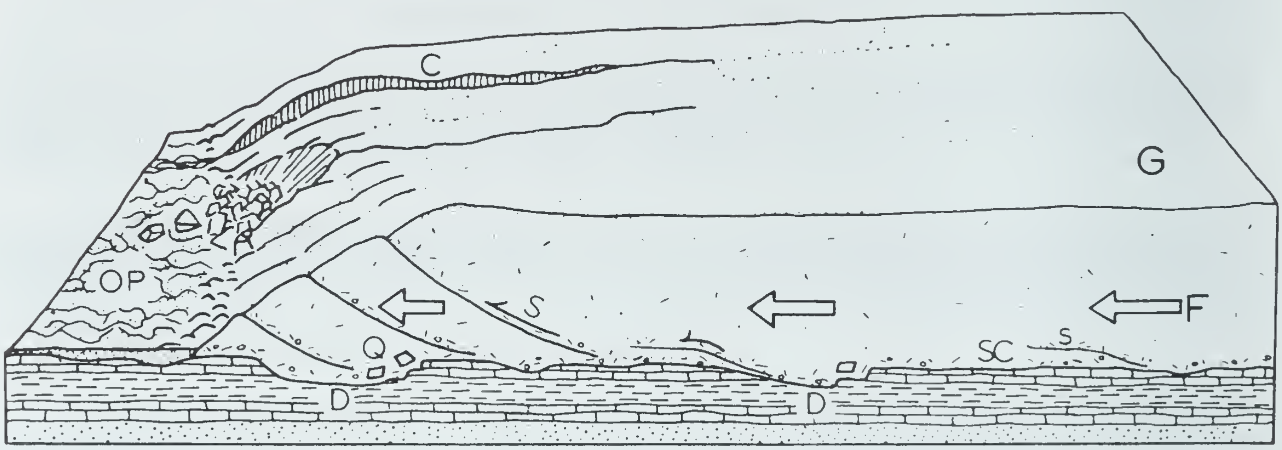
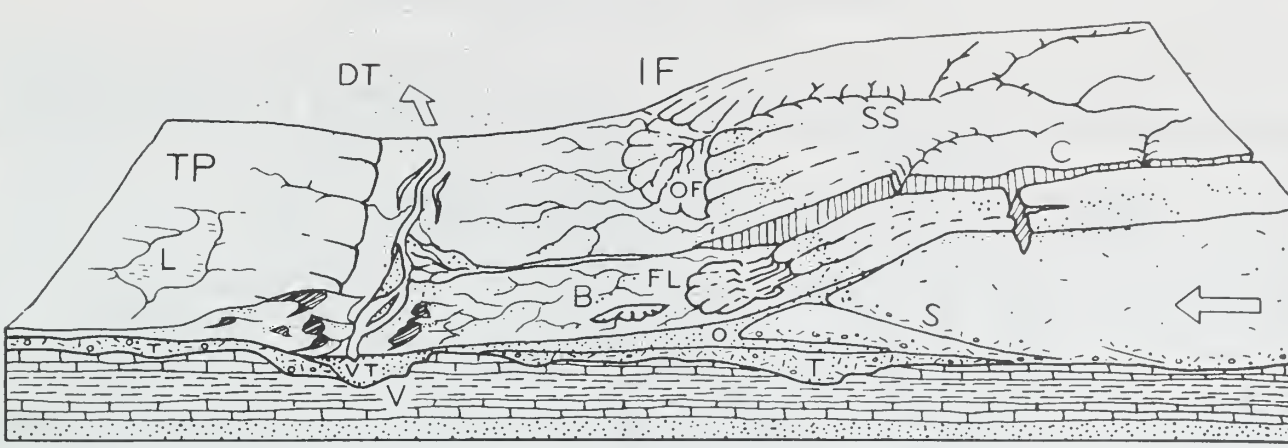


1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



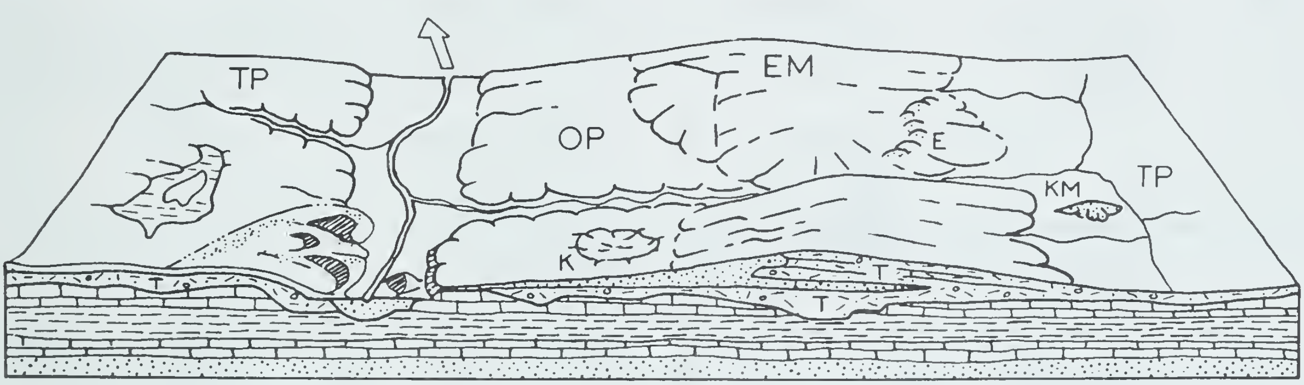
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

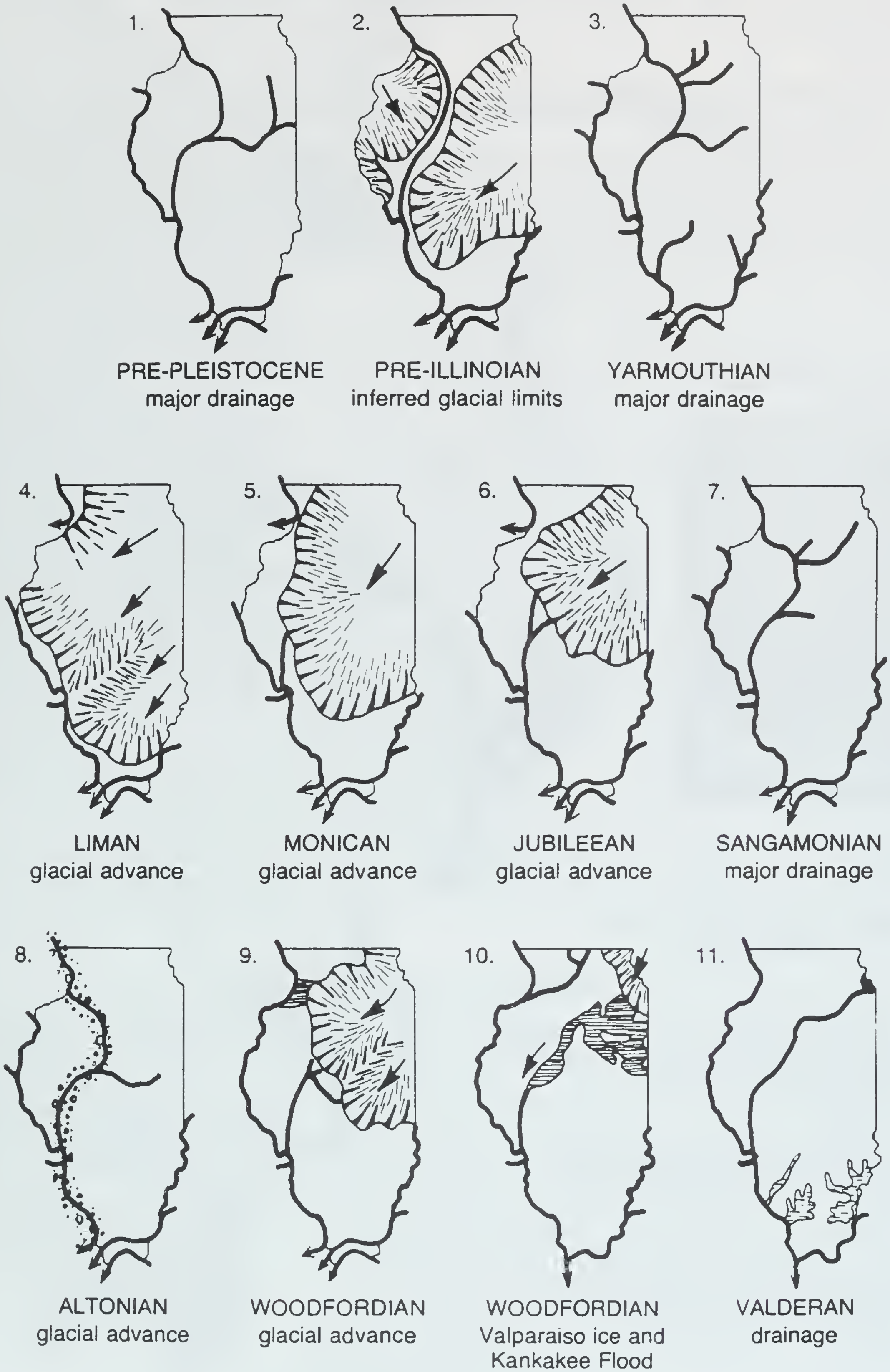
TIME TABLE OF PLEISTOCENE GLACIATION

			STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY			HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
					10,000		
	Pleistocene		WISCONSINAN (glacial)	late	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
					11,000		
				late	Twocreekan	Peat and alluvium	Ice withdrawal, erosion
					12,500		
				late	Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
					25,000		
				mid	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
					28,000		
				early	Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
					75,000		
			SANGAMONIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
					125,000		
			ILLINOIAN (glacial)		Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
					Monican	Drift, loess, outwash	
					Liman	Drift, loess, outwash	
					300,000?		
			YARMOUTHIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
					500,000?		
		Pre-Illinoian	KANSAN* (glacial)			Drift, loess	Glaciers from northeast and northwest covered much of state
					700,000?		
			AFTONIAN* (interglacial)			Soil, mature profile of weathering	(hypothetical)
					900,000?		
			NEBRASKAN* (glacial)			Drift (little known)	Glaciers from northwest invaded western Illinois
					1,600,000 or more		

*Old oversimplified concepts, now known to represent a series of glacial cycles.

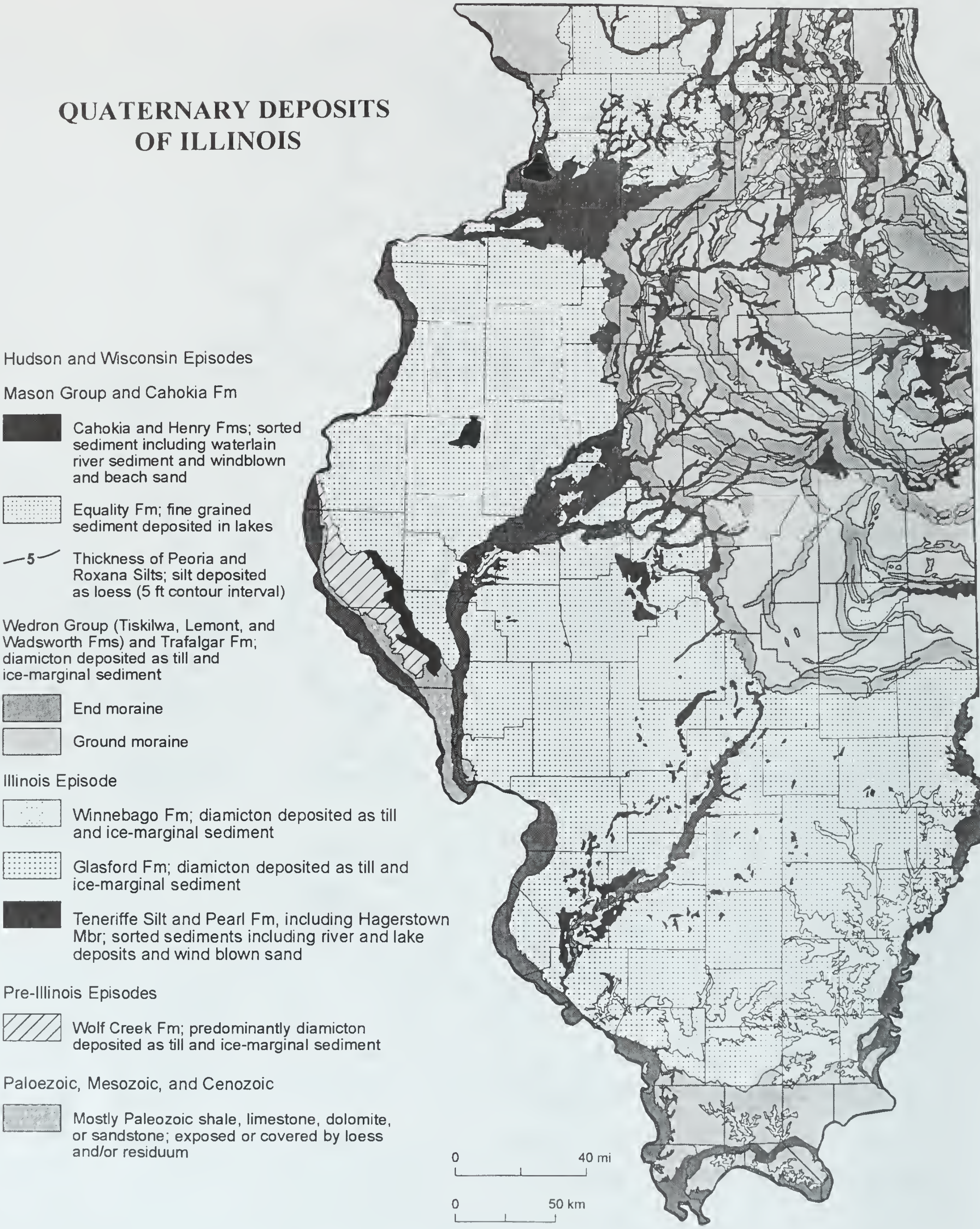
(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

QUATERNARY DEPOSITS OF ILLINOIS



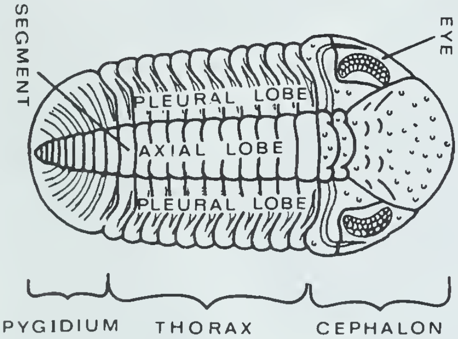
The Trilobite — An Early Inhabitant of Illinois

Ceraurus cf. *pleurexanthemus* Green. Found in Ordovician age rocks of the Grand Detour Formation, Platteville Group, near Rockford, Illinois (shown lifesize).

Many strange creatures have inhabited Illinois in the past and have left their fossil remains entombed in the rocks that underlie our prairie lands. One such animal is the trilobite, an extinct marine arthropod that is distantly related to the living crabs, lobsters, and crayfish.

Trilobites were among the earliest inhabitants of Illinois. The oldest specimens have been found in Cambrian age rocks formed approximately 500 million years ago (see chart). After the Ordovician Period the trilobites slowly declined in abundance and diversity, finally becoming extinct at the close of the Permian Period, about 200 million years ago. They swam in the warm, shallow seas that covered all of Illinois and most of North America and crawled on and burrowed in the muddy sea bottoms. As the seas advanced and retreated over a span of about 350 million years (Paleozoic Era), the trilobites slowly evolved — that is, changed structurally and functionally through time — into a great variety of forms. They were variously adapted as scavengers, predators, and filter feeders that occupied niches in the level sea bottoms and in reef communities. Trilobites lived with sponges, corals, clams, snails, brachiopods, crinoids, and other marine animals.

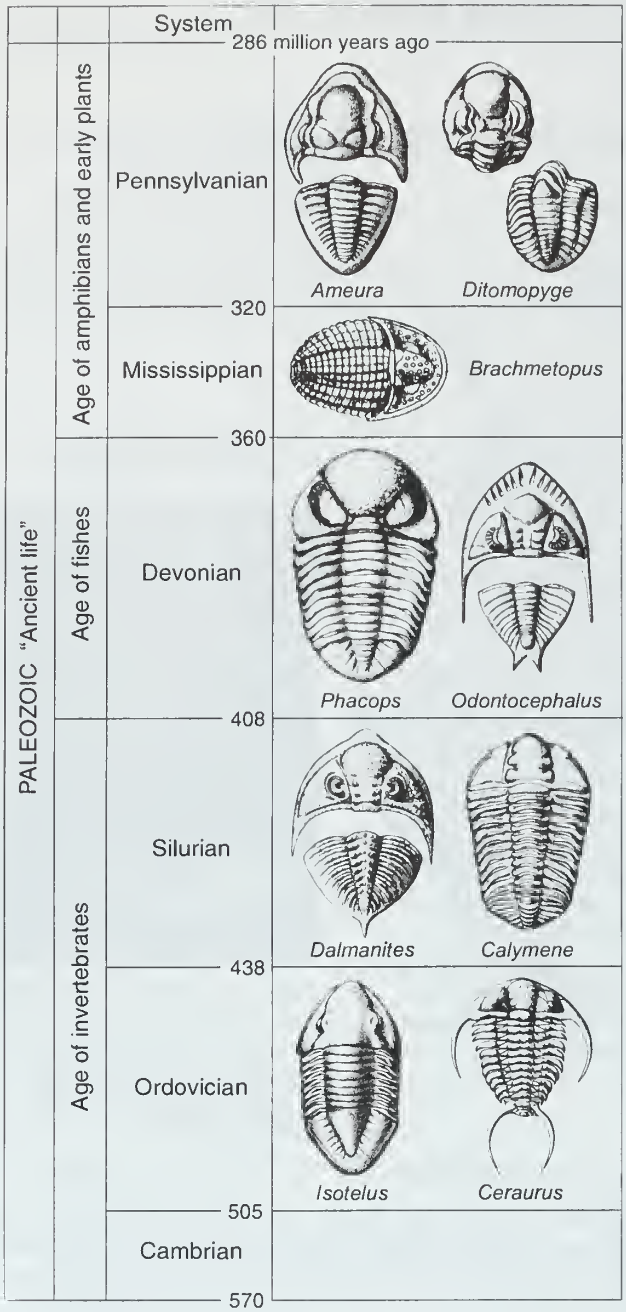
Calymene celebra Raymond. Dorsal (top) and side views of a specimen found in the Silurian age Racine Formation near Grafton, Illinois (shown lifesize).



Dorsal view of *Phacops*, a common Devonian trilobite, showing various structures (shown lifesize).

Trilobite structure

Trilobites are so named because the segments on their upper (dorsal) surface usually possess longitudinal furrows that form a three (tri-) lobed division of the body. The central lobe is called the axial lobe, and the two lateral counterparts are called pleural lobes. The dorsal surface consisted of a hard, mineralized protective shield called a carapace; it is this part of the shell, or exoskeleton, that is most commonly preserved in the fossil record. The lower (ventral) surface bore a pair of antennae and numerous pairs of jointed appendages that served as walking, swimming, feeding, and respiratory organs. The ventral surface, however, consisted of relatively soft tissue and rarely is preserved. A typical trilobite is about 2 inches long, but some are less than half an inch in length and giants of the group measure fully 2 feet.



Like the living crustaceans (crabs, lobsters, crayfish, etc.), trilobites shed their shells periodically in order to grow. In some species a single trilobite produced 27 shells or more. In fact, it is very likely that most trilobite fossils are the discarded shells. Although trilobite fragments are rather abundant in some rocks, complete specimens are rare. It was only under the most exceptional conditions, such as burial by sediment before or immediately after death, that complete trilobites were preserved relatively unchanged.

The popular fossil

Because of their unusual and interesting appearance, trilobites are among the fossils most sought after for collection and study. Avid collectors continually comb the countryside searching for new trilobite localities. The best collecting is at outcrops of shale, limestone, and dolomite in quarries, roadcuts, and natural exposures. The Paleozoic rocks of Illinois have long been known for their abundant and well-preserved trilobite fossils. Cambrian age trilobites have been found in a few small outcrops in north-central Illinois and in several cores drilled from deeply buried rocks at various localities throughout the state. Some of the better trilobite collections have been made from the more accessible Ordovician and Silurian rocks that are exposed in the northern and southwestern parts of the state. Trilobites have been found in some post-Silurian Paleozoic rocks in Illinois, but they are much less abundant and diverse than those in the older rocks.

Trilobite dating

The study of trilobites is not just an academic exercise. Trilobites are useful in determining the relative age of some sedimentary rocks. Knowing the relative age is important for economic reasons, particularly where it is necessary to locate and identify strata containing oil, natural gas, coal, and ore deposits. The study of such index fossils and their relationship to the strata in which they are found is called biostratigraphy.

Contributed by Dennis R. Kolata

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

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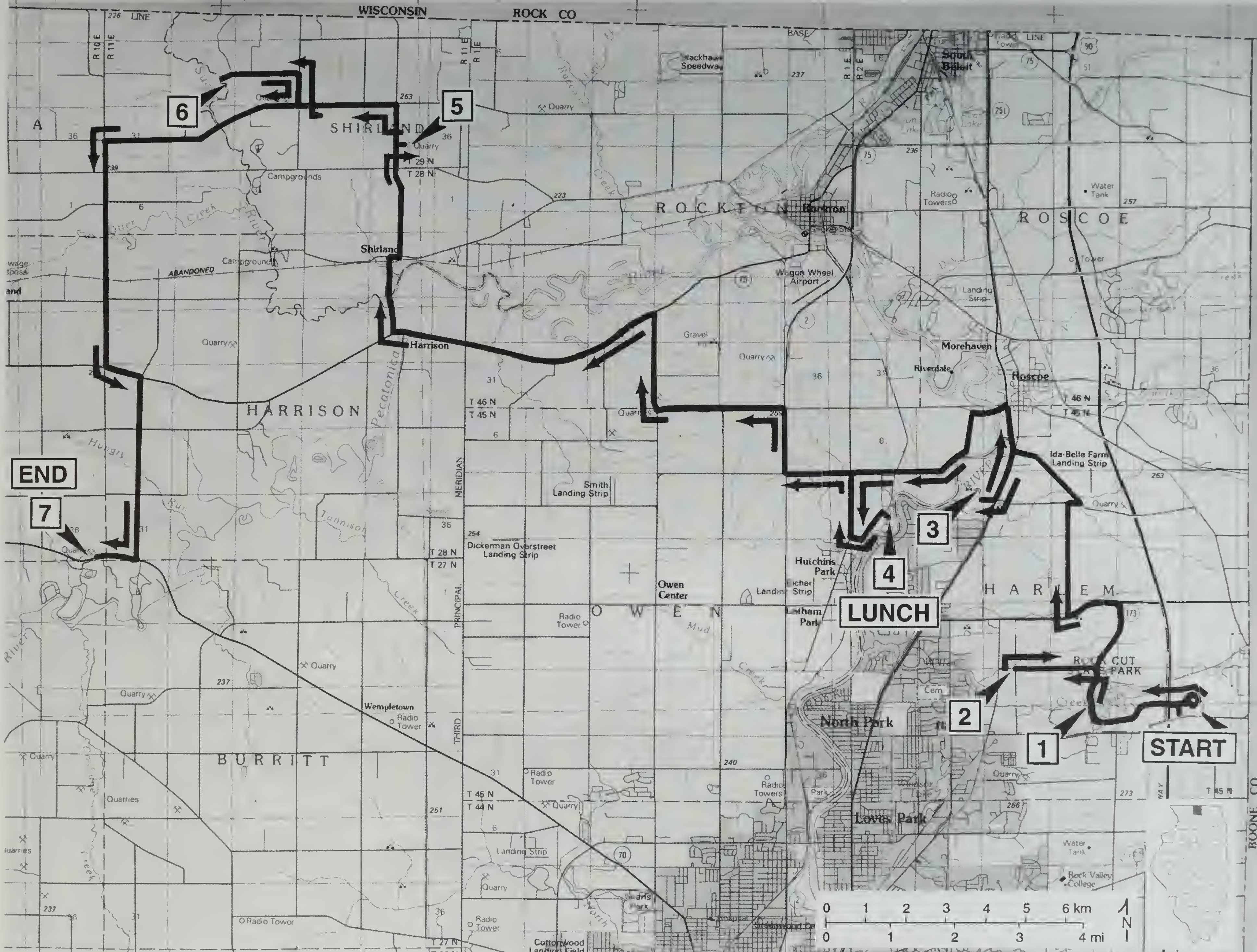
ORDOVICIAN FOSSILS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SHIRLAND
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Rockton
South Beloit
Roscoe
Morehaven
Riverdale
North Park
Loves Park
Owen Center
Wempletown
ROCK CUT STATE PARK
Hutchins Park
Latham Park
Wagon Wheel Airport
Ida-Belle Farm Landing Strip
Smith Landing Strip
Dickerman Overstreet Landing Strip
Cottonwood Landing Field
Rock Valley College
Blackhawk Speedway
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